Student Performance and its Association with Utilisation of Teaching Material

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Abstract: This study examines the utilization of online course material by students and evaluates the relation with students' subsequent performance in assessments. Evidence is provided of the extensive utilization of online course material, although the pattern of utilization suggests that the label of 'digital natives' being applied to these students may be somewhat presumptuous. Specifically there is some evidence of a positive link between utilisation of practical exercises and performance as well as lecture slides and performance. No significance is found for either the utilisation of the discussion questions, quizzes or podcasts. Whilst we have made a necessary first step in order to ascertain impact of student utilisation and performance, a bigger question remains. How to increase students' timely utilisation of material?

Keywords: Learning Management System, Utilization, Student Performance

1. Introduction

The provision of course material, including lecture notes and overheads, to students through learning management systems is commonplace in Australian universities, and the practice is well documented in the literature (e.g. Jensen, 2007). Similarly, provision of lecture recording on magnetic tape cassettes dates back at least three decades, and is common place in provision of distance education. However, the digital recording of lectures and making these available to students generally through a learning management system (now referred to as podcasting) is a much more recent phenomenon and has only really impacted on the tertiary education sector for the past 3-4 years (Sull, 2005). This paper addresses the issues of how students utilise course materials and lecture recordings, and more importantly, how the pattern of utilisation impacts student academic performance.

There has been a shift in Business education in recent years from a physical classroom based system to one in which is much more heavily supported by Web-based and Web-supported learning environments (Sonwalker, 2001). Whilst there is evidence that students consider the provision of online material as being of 'excellent value' to them in their studies (Tynan and Colbran, 2006), there is a dearth of evidence of whether provision of online material has an significant impact on student performance.

To address this it is first necessary to consider student utilisation of course materials, and then evaluate the relation between student utilisation of course materials and performance. This is necessary to determine whether online course materials really represent 'excellent value' and if students are getting value from the act of downloading these course materials.

This study is based on a sample of 574 students undertaking a second year subject in the business faculty of an Australian university. To be included in the sample students had to complete the final exam in the formal exam period. Results show that student utilization of course materials is not timely, with less than one third of students downloading materials prior to class. In relation to student performance, the utilization of practical exercises and lecture slides by students are significantly related to overall student performance in the subject.

The remainder of the paper is organised as follows. Section 2 provides a review of the existing literature and develops hypotheses. Research design and sample selection are addressed in sections 3 and 4. The results are presented in section 5, and the conclusions and suggestions for future research are discussed in section 6.

2. Literature review and hypotheses

Education is now Australia's second largest export industry within the services sector and the fourth largest export earner overall (Simmonson, 2005). The demand for educational services, both domestically and internationally, is on the rise and at the same time government support for is

declining.1 This growth in the demand for higher education and decline in government support has naturally translated into larger class sizes, and it was recently reported that Australian university student teacher ratios are amongst the highest in the world at around 20:1 (Milbourne, 2007). A natural reaction to these large class sizes, the need to deliver quality educational services, and the phenomenon of 'time-poor' students electing not to attend lectures (Holland & Pithers, 2007) has been the offering of students an alternative to lecture attendance.

The provision of course material (such as lecture notes, lecture podcasts, screencasts, tutorial questions, solutions) online via learning management systems is seen as one such alternative, and there has been an increasing shift by universities towards the usage of these online systems (Weaver et al. 2008). The current generation of young university students have been tagged by Prensky (2001) as 'digital natives' as they all speak the digital language of computers, video games and the internet (Tynan & Colbran 2006). Furthermore, students have widespread access to the internet in Australia, not only at home, with 66% of households in major cities having access in 2006 (ABS, 2006), but also high speed broadband on campus. A consequence of this is that accessing such material should not present logistical problems for students as they already have access to and are familiar with the technology. While the presence of a new technology often has a novelty factor which can influence both teachers and students into adopting it, there needs to be more persuasive reasons for the long-term adoption of such technologies. As Lee (2005) points out with the adoption of new technologies there is a need to think carefully about "whether or not this is actually going to result in meaningful learning" (p19).

With this in mind this study attempts to address the question of how students use the available online course material, and evaluates whether the use of online course material results in enhanced assessment performance. This is reflected in the following hypothesis:

H1: There is a positive association between the utilisation of online course material and student performance.

3. Research design

In testing the hypotheses a combination of univariate and multivariate tests were undertaken. In the first instance this simply considered differences in student utilisation of teaching material across students partitioned by performance. This was followed by multivariate tests that introduced controls for student ability and language ability, taking the following form:

$$StudentPerformance_i = \alpha_0 + \sum_{j=1}^{5} \alpha_j TeachingMaterial_i + \alpha_6 WAM_i + \alpha_7 ENGLISH_i + \varepsilon_i$$

3.1 Student performance

Student performance was measured as the overall result obtained in a second year subject in a business faculty in an Australian university. This incorporated results from assessments throughout the semester and in the final exam.

3.2 Teaching material

A range of teaching materials were provided to students to facilitate their attainment of the necessary learning outcomes, including discussion questions (DISC), practical exercises (EXER), quizzes (QUIZ), copies of lecture slides (SLID) and lecture recordings (REC). These were made available to students weekly through an internet based learning management system, and student utilisation of this material was determined on the basis of whether students accessed the material from an internet based learning management system. This was tracked and categorised as prior to the relevant lecture or tutorial (TUT), subsequent to the relevant lecture or tutorial but before the end of the teaching semester (SEM), or at anytime during the semester (ANY). Accordingly, DISC-TUT captures the number of weeks where a student accesses discussion questions before the relevant tutorial.

[1] *Growing Esteem: Choices for the University of Melbourne, 2005*

3.3 Controls

Student performance is likely to be influenced by ability (Williams and Clark, 2004). The best available measure of this is student performance at university prior to the current semester (subject). This measured by the students' weighted average mark (WAM).

Performance is also likely to be influenced by the language ability of the student. It is likely that students with better English language skills (the language in which the subject is taught and assessed) will better understand the questions, and accordingly will be expected to better perform in the assessment (Johnson, 2005). In this study language ability is measured by whether students have identified on enrolment if English is the only language spoken at home. If this is the case the variable ENGLISH adopts the value 1, otherwise 0.

3.4 Sample

This study is based on a sample of students undertaking a second year subject in the business faculty of an Australian university. To be included in the sample students had to complete the final exam in the formal exam period. This provided a sample of 574 students. Students who did not complete the assessment or undertook an assessment at a later date are excluded.

4. Results

4.1 Descriptive statistics

The descriptive statistics are presented in Table 1. The students' usage of teaching materials follows a predictable pattern, with some slight variation dependent on the actual material in question.

Descriptive statistics for student utilisation of teaching material and overall performance in the subject, together with controls for student ability (WAM) and language ability (ENGLISH).

Table 1: Descriptive statistics

	Mean	Median	Minimum	Maximum	Std. Dev.
DISC-TUT	4.256	4	0	11	2.311
DISC-SEM	6.693	7	0	10	2.367
DISC-ANY	8.974	10	0	11	2.201
EXER-TUT	2.855	3	0	9	1.955
EXER-SEM	4.836	5	0	8	2.221
EXER-ANY	7.634	9	0	9	2.001
QUIZ-TUT	0.594	0	0	4	0.789
QUIZ-SEM	7.375	8	0	11	2.808
QUIZ-ANY	10.542	12	0	12	2.641
SLID-PRIOR	3.648	3.5	0	11	2.100
SLID-SEM	8.125	9	0	11	2.292
SLID-ANY	9.427	10	0	11	2.108
REC-ANY	6.366	6	0	12	4.497
WAM	57.713	58.155	0.000	87.630	13.242
ENGLISH	0.254	0.000			
OVERALL	55.659	57	9	94	13.788

Where:

DISC-TUT	:	The number of weeks a student downloaded the discussion questions in the weeks of the lecture or tutorial
DISC-SEM	:	The number of weeks a student downloaded the discussion questions subsequent to the weeks of the lecture or tutorial, but before the end of semester
DISC-ANY	:	The number of weeks a student downloaded the discussion questions at any time prior to the exam.
EXER-TUT	:	The number of weeks a student downloaded the computational / exercise questions in the weeks of the lecture or tutorial
EXER-SEM	:	The number of weeks a student downloaded the computational / exercise questions subsequent to the weeks of the lecture or tutorial, but before the end of semester
EXER-ANY	:	The number of weeks a student downloaded the computational / exercise questions at any time prior to the exam.
QUIZ-TUT	:	The number of weeks a student completed a revision quiz in the weeks of the lecture or tutorial
QUIZ-SEM	:	The number of weeks a student completed a revision quiz subsequent to the weeks of the lecture or tutorial, but before the end of semester
QUIZ-ANY	:	The number of weeks a student completed a revision quiz at any time prior to the exam.
SLID-TUT	:	The number of weeks a student downloaded the lecture overheads prior to the lecture.
SLID-SEM	:	The number of weeks a student downloaded the lecture overhead subsequent to the lecture or tutorial, but before the end of semester
SLID-ANY	:	The number of weeks a student downloaded the lecture overheads at any time prior to the exam.
REC-ANY		The number of weeks a student downloaded a recording of the lecture at any time prior to the exam.
WAM	:	Weighted average mark for student while undertaking course, measured prior to the current semester
ENGLISH	:	Dummy variable set to 1 if the student on enrolment has identified "English only" and the language spoken at home.
OVERALL	:	Student result for the subject.

On average, students do not download the material on a timely basis. Of the 11 weeks of discussion questions available, the average number of downloads per student is 4.256. This means that on average, students are downloading 39 percent of tutorial questions for the semester. By the end of the regular teaching semester, students, on average, have downloaded 6.693 (61 percent) of the available discussion questions, and by the final exam date have downloaded 8.974 (82 percent).

The practical questions (EXER) tell an almost identical story. The practical questions only begin in Week 3, and as such only 9 weeks are available for students. On average, students download 2.855 (32 percent) of the practical questions up to and including the week of the tutorial. By the end of the semester, they have downloaded 4.836 (54 percent), and by the exam 7.634 (85 percent). These percentages are very similar to the discussion questions.

The use of the revision quizzes (QUIZ), exhibits a similar reaction, although the magnitudes are different. The mean quiz attempts to end of the week of the tutorial is 0.594, with a median of 0. Students do not seem to use the quizzes for immediate revision. However, by the end of the semester, the mean quiz attempts is 9.427, with a median of 12 (the maximum). It does seem that students do use the quizzes for revision, but just not around the time of the tutorial. Whether or not this method for revising is beneficial will be addressed later in the results section.

An interesting result, and one for which we have no reasoning for, is the lack of student downloads of lectures prior to the lecture occurring. Of the 11 lectures held, the mean downloads was only 3.468 (32 percent). Whilst by the end of the semester the downloads have increased to 9.427 (86 percent), it is still surprising that less than a third of students actively download the lecture material prior to the lecture occurring.

Finally, the recordings should that on average students download approximately half of the available recordings (6.366 out of 12 available). Student WAM for the subject is 57.713, non-English speaking background (NESB) students make up just under 75 percent of the course, and the average final grade for the subject was 55.659.

Overall the results in Table 1 tend to suggest that students tend not to engage with the subject on a timely basis. One potential explanation is that these descriptives are simply picking up those students

who attend the tutorials and lectures, with the remainder doing the work in their own time. Whilst attendance is not marked in either the tutorials or the lectures, attendance certainly does not drop to this level. In any event, regardless of whether students are attending the tutorials or lectures or not, they do not seem to be accessing the material on a timely basis.

A second explanation is that students are working together and one student is downloading the material and then either printing copies for others, or providing electronic copies via USB. Whilst this is possible, we do see students who do not download the material early in the semester, download the material later on, which suggests they did not access it via other means previously.

4.2 Univariate results

Table 2 documents the univariate results of the impact of utilisation on student performance. The students are partitioned into six even groups based on overall subject performance. The mean downloads for each partition is then compared using an Anova F-test. A significant result provides evidence that students that perform better overall access the material at a different rate than those that perform poorly.

Analysis of difference in students utilisation of teaching material and student performance. Anova F-test calculated for differences of means and Kruskal Wallis test of differences in medians

Table 2: Univariate tests of performance differences associated with student utilisation of teaching material

Panel A: Discussion Questions						
	DISC11OR2		DISC1SEM		ANY	
	Mean	Median	Mean	Median	Mean	Median
1	4.214	4	6.449	6	8.510	9
2	3.505	3	6.379	7	9.063	10
3	4.192	4	6.692	7	9.123	10
4	4.346	5	7.038	7	9.404	10
5	4.642	5	7.038	8	9.217	10
6	4.667	5	6.688	7	8.645	10
All	4.256	4	6.693	7	8.974	10
Anova F-statistic	3.287	0.006	1.216	0.300	2.112	0.062
Kruskal-Wallis	16.658	0.005	6.950	0.224	7.699	0.174
Panel B: Practical Exercises						
	EXER11OR2		EXER1SEM		ANYTIME1	
	Mean	Median	Mean	Median	Mean	Median
1	2.551	2	4.367	4	7.316	9
2	2.400	2	4.474	4	7.968	9
3	2.815	3	5.054	5	7.785	9
4	2.481	2	4.692	5	7.577	9
5	3.047	3	5.104	5	7.425	8
6	3.688	4	5.172	6	7.688	9
All	2.855	3	4.836	5	7.634	9
Anova F-statistic	5.700	0.000	2.436	0.034	1.432	0.2107
Kruskal-Wallis	26.638	0.000	10.799	0.056	6.223	0.2851
Panel C: Solutions to Practical Exercises						
	SOLS11OR2		SOLS1SEM		ANYTIME101	
	Mean	Median	Mean	Median	Mean	Median
1	2.061	2	4.041	3	7.041	8
2	2.221	2	4.232	3	7.695	9

3	2.323	2	4.485	4	7.562	9
4	2.442	2	4.173	4	7.135	8
5	2.415	2	4.783	5	7.132	8
6	2.849	2	4.839	5	7.387	8
All	2.375	2	4.451	4	7.348	8
Anova F-statistic	1.962	0.083	1.901	0.092	1.399	0.223
Kruskal-Wallis	8.589	0.127	8.935	0.112	6.704	0.244
Panel D: Quizzes						
					AnyQUIZ	
					Mean	Median
1	0.622	0.000	7.480	8.000	10.459	12
2	0.505	0.000	6.916	7.000	10.505	12
3	0.592	0.000	7.462	8.000	10.554	12
4	0.692	0.500	7.635	8.000	11.038	12
5	0.604	0.000	7.302	8.000	10.434	12
6	0.591	0.000	7.548	8.000	10.495	12
All	0.594	0.000	7.375	8.000	10.542	12
Anova F-statistic	0.429	0.829	0.732	0.599	0.430	0.828
Kruskal- Wallis	2.172	0.825	3.024	0.696	2.218	0.818
Panel E: Lecture Slides						
	SLIDESPRIOR		SLID-SEM		SLIDESAny	
	Mean	Median	Mean	Median	Mean	Median
1	3.398	3	7.429	8.000	8.929	10
2	3.095	3	7.832	8.000	9.137	10
3	3.485	3	8.008	8.000	9.338	10
4	3.596	4	8.462	9.000	9.731	10
5	3.802	4	8.396	9.000	9.717	10.5
6	4.559	4	8.828	9.000	9.871	11
All	3.648	3.5	8.125	9.000	9.427	10
Anova F-statistic	5.591	0.000	4.599	0.000	2.995	0.011
Kruskal-Wallis	24.834	0.000	21.159	0.001	10.072	0.073
Panel F: Lecture Recordings						
					Anytime	
					Mean	Median
1					6.163	6
2					5.905	6
3					6.785	7
4					5.981	6
5					6.377	6
6					6.667	7
All					6.366	6
Anova F-statistic					0.622	0.683
Kruskal-Wallis					2.934	0.710

Columns 2 and 3 represent the mean and median respectively for downloads up to and including the week of the tutorial, Columns 4 and 5 document the mean and median for downloads during the semester, and Columns 6 and 7 provide the mean and median for downloads up to the final exam.

Panel A documents the results for the Discussion Questions. There is a significant difference in the means for both the week of the tutorial (p = 0.006) and anytime up to the final exam (p = 0.062). However there is no evidence of students who perform better downloading more during the semester itself.

The results for the Practical Exercises are shown in Panel B. Similar to Panel A, there is a positive and significant difference for the week of the tutorial (p = 0.000). However the better performing students also tend to download the practical exercises more during the rest of the semester (p = 0.034), but there is no difference when taking the whole semester up to the final exam, into account. The results for the Solutions are shown in Panel C. These are qualitatively similar to the Panel B results, which is not surprising as the two sets of documents are inter-linked.

The Quiz results, shown in Panel D have no significance. This suggests that well performing and poor performing students students access this material at a fairly similar level. The lecture slides, Panel E are a different story, with significance for each grouping. Whilst better performing students may not use the quizzes more, than do seem to be downloading the lecture slides more, not only on a timely basis, but for the semester overall Finally, Panel F, lecture recordings, shows no significance.

Overall, the results from Table 2, whilst not completely consistent tend to suggest that there is an association between the utilisation of the teaching material and performance in the subject. Specifically, for four of the five documents for which students can download ahead of time (i.e. before the lecture or the tutorial), those students who make greater use of the material perform better in the subject. Similar, but not such strong results also hold for downloads through the semester and also up to the final exam. However this analysis does not control for student attributes. This will be covered in the following section.

4.3 Multivariate results

The multivariate results are shown in Table 3. The model includes the students' overall result as the dependent variable, with the independent variables representing the utilisation of the teaching materials plus controls for student aptitude (WAM) and English ability (ENGLISH). Models 1 through 3 only vary by the utilisation metric used. Model 1 uses utilisation up to and including the week of the tutorial/lecture. Model 2 includes utilisation during the semester and Model 3 includes utilisation full utilisation up to the final exam. Model 4 is a modification of Model 3 and includes an additional variable to reflect utilisation of the podcasts.

Analysis of difference in student results conditional on student utilisation of teaching material and controls for student ability (WAM) and English ability (ENGLISH).

Table 3: Multivariate tests of performance differences associated with student utilisation of teaching material

Co-efficient	Equation			
	TUT	SEM	ANY	
	(DISC-TUT, EXER-TUT, QUIZ-TUT, SLID-TUT)	(DISC-SEM, EXER-SEM, QUIZ-SEM, SLID-SEM)	(DISC-ANY, EXER-ANY, QUIZ-ANY, SLID-ANY)	
C	20.848	16.644	15.617	15.792
t-stat	9.450	5.965	4.116	4.152
p-value	0.000	0.000	0.000	0.000
DISC	-0.109	0.125	0.039	0.028
t-stat	-0.426	0.528	0.175	0.126
p-value	0.670	0.597	0.862	0.900
EXER	**0.926**	**0.492**	0.146	0.141
t-stat	**3.155**	**1.960**	0.596	0.573
p-value	**0.002**	**0.051**	0.552	0.567
QUIZ	-0.098	-0.157	0.174	0.152
t-stat	-0.155	-0.923	0.831	0.721

Co-efficient	Equation			
p-value	0.877	0.356	0.406	0.471
SLID	0.281	**0.548**	0.406	0.368
t-stat	0.530	**2.487**	1.753	1.549
p-value	0.596	**0.013**	0.080	0.122
REC-ANY				0.081
t-stat				0.741
p-value				0.459
ENGLISH	**3.608**	**3.306**	**3.365**	**3.359**
t-stat	**3.230**	**2.971**	**2.969**	**2.963**
p-value	**0.001**	**0.003**	**0.003**	**0.003**
WAM	**0.545**	**0.549**	**0.557**	**0.558**
t-stat	**14.641**	**14.978**	**15.073**	**15.077**
p-value	**0.000**	**0.000**	**0.000**	**0.000**
Adjusted R-squared	0.347	0.353	0.338	0.337
F-statistic	51.826	53.118	49.652	42.604
Prob(F-statistic)	0.000	0.000	0.000	0.000

Where:

$$Overall_i = \alpha_0 + \sum_{j=1}^{5} \alpha_j TeachingMaterial_i + \alpha_6 WAM_i + \alpha_7 ENGLISH_i + \varepsilon_i$$

All variables as previously defined

All models are significant (p = 0.000), and with adjusted R2's of between 33.7 percent and 35.3 percent show good explanatory power in a student performance model (Johnson, 2005). The control variables, WAM and ENGLISH are positive and highly significant in each of the four models.

Turning to experimental variables, the utilisation of the discussion questions, quizzes or podcasts are not significantly associated with overall student performance. The quizzes and podcasts can most likely be explained by Table 2, with similar rates of use for students who perform well and poorly in the subject. But it does not explain the lack of result on the discussion questions. One reason may be the nature of the subject material. The discussion questions often relate to case work or open ended questions which require students to critically analyse issues relating to the regulation of financial reporting. Anecdotally many students, especially NESB students find this uncomfortable and difficult. It may be that even if they download and attempt these questions, they still do not fully understand the ideas, and as such are no likely to perform better in the exam than those students who did not.

The results for Exercises may bear out this argument. The utilisation of practical exercises is positive and significant both in the week of the tutorial and for anytime during the semester. No significance is found in Models 3 or 4. This no result makes sense, in that the poor performing students who have downloaded in the final couple of weeks mask the utilisation measure.

The association found between timely Practical Exercise downloads and student performance indicates that for tasks in which students are more comfortable, i.e. calculation questions, time spent on task is beneficial. As such those who do download, especially early do get benefit from working through the questions.

Finally the utilisation of lecture slides is positively significant for downloads during the semester and any time. Strangely there is no impact for those students who download the lecture slides in preparation for the lecture. Intuition would suggest that the minority of students who download the material prior to the lecture are the more conscientious students and more likely to succeed. But this appears not to be the case. Or, at the very least WAM crowds out any effect.

5. Conclusions

This study examines the impact the utilisation of teaching materials has on student performance. We find that students do not download material on a timely basis, with less than a third of students downloading materials for tutorials or lectures prior to class2. Even by the end of semester students will have accessed, on average, only 80 percent of available materials.

The univariate results strongly point to a positive association between utilisation and performance, especially in relation to timely accessing of materials. However, the multivariate results only show limited results. Specifically there is some evidence of a positive link between utilisation of practical exercises and performance as well as lecture slides and performance. No significance is found for either the utilisation of the discussion questions, quizzes or podcasts.

Whilst we have made a necessary first step in order to ascertain impact of student utilisation and performance, a bigger question remains. How to increase students' timely utilisation of material?

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[2] Untabulated results suggest this issue is actually more significant, with the majority of downloads prior to class occurring either the day before or the day of.

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