

**DOES REGULAR ONLINE TESTING
ENHANCE STUDENT LEARNING?
EVIDENCE FROM A LARGE FIRST-YEAR
QUANTITATIVE METHODS COURSE**

Judith Watson and Simon Angus

Australian School of Business
University Of New South Wales

Introduction

- Our paper looks at changes made to a large first year course at UNSW with a focus on the impact of online quizzes.
- In particular we look at whether the actual engagement in the online assessment process leads to an improved learning outcome.
- There is a large literature on the use of technology and online learning but only a few articles (e.g. Cassady et al.,2001 and Zappe et al.,2002) relate to quantitative courses.

- Many of the studies relating to this area (e.g. Stillson, 2003; Hagerty et al., 2005) do not use sample sizes as large as ours.
- We use large numbers of explanatory variables to rigorously examine the effects of engaging in online learning.
- We have controlled for factors such as grades in other assessment in the course, prior maths ability, gender and international status and have examined cohorts in both academic sessions.

Course background information

- Quantitative Methods A (QMA) is a first year core applied mathematics course
- Enrolment: Session 1 1300
Session 2 450
- Review began 2005. Changes were implemented Session 2 2006
- Changes included curriculum, lecture and tutorial presentation and materials, web resources.
- Changes to assessment drove our new approach to engagement and learning.

assessment changes

Old structure	% of total	New structure	% of total
2 x 15 minute written tutorial quizzes, weeks 6 and 12	10%	4 x 1 hour e-quizzes, weeks 4,6,10 and 14	8%
Mid-term multiple choice exam, week 8	20%	Mid-term multiple choice exam, week 8	20%
Computer labs - attendance only	5%	Group computing assignment, Part A week 7, Part B week 12	12%
Final Written Exam	65%	Final Written Exam	60%

E-quiz design

- Quizzes used calculated questions with variables which generated 80 sets of random numbers.
- They were written using the Respondus program and ran on WebCT Vista.
- Each quiz was open online for 1 week (Monday morning to Sunday night).
- Students were allowed two one hour attempts.

Quiz item preview

Preview Current Item

Appearance in Internet Explorer (other browsers may vary slightly).

OK

$$A = \begin{bmatrix} 6 & a \\ -1 & 2 \end{bmatrix} B = \begin{bmatrix} 3 & -7 \\ 6 & b \end{bmatrix} C = \begin{bmatrix} c & -3 \\ 4 & 5 \end{bmatrix}.$$

and $A^{-1}XB = C$

When $a = -2$, $b = 1$ and $c = -2$ what is the value of X_{11} correct to two decimal places?
(Show decimal places even if your answer is an integer)

Answer:

Correct Answer
3.29

question construction

Respondus - QMA quiz3.rsp

File Edit View Help

B
 x_2
 x^2
 Σ

 Power Edit

Start **Edit** Settings Preview & Publish Retrieval & Reports

Edit Questions

- Multiple Choice
- True False
- Paragraph
- Matching
- Short Answer
- Multiple Response
- Fill in the Blank
- Jumbled Sentence
- Calculated**

Enable Feedback

Copy from Another File

Calculated

1. Title of Question

2. Question Wording

<EQ_1>

When $a = [a]$, $b = [b]$ and $c = [c]$ what is the value of X_{11} correct to two decimal places?
(Show decimal places even if your answer is an integer)

3. Type or Create the Formula. Enclose variables in [square brackets]

Variables Functions Operators Constants

$$((6*[b]*[c])+(4*[a]*[b])+108-(30*[a]))/(3*[b]+42)$$

4. Value/Answer Sets 5. Point Value

Question List

#	Title	Format	Question Wording
1	Determinant	Calculated	What is the value of the determinant \square when $a = [a]$ and $b = [b]$
2	matrix mult inverse	Calculated	\square . When a

Did feedback to students improve?

Table 2: Pre- and Post-Change Evaluation of Feedback

Question: I was given helpful feedback on how I was going in the course							
Session	Strongly Agree	Agree	Disagree	Strongly Disagree	n	Chi-square	p-value
1, 2006 (pre)	33	216	125	25	399	50.1724	7.34E-11
1, 2007 (post)	124	252	94	25	495		
2, 2005 (pre)	4	51	38	9	102	10.55132	0.014417
2, 2006 (post)	17	92	35	8	152		

Were students more satisfied?

Table 3: Pre- and Post-Change Evaluation of Satisfaction

Question: Overall, I was satisfied with the quality of this course							
Session	Strongly Agree	Agree	Disagree	Strongly Disagree	n	Chi-square	p-value
1, 2006 (pre)	42	254	75	29	400	93.56039	3.76E-20
1, 2007 (post)	150	315	30	5	500		
2, 2005 (pre)	3	61	26	9	99	10.45954	0.015038
2, 2006 (post)	22	95	27	10	154		

Students' opinion on e-quizzes

Evaluation Question (Session1, 2007)

“The online e-quizzes were a useful tool to help me to study consistently throughout the course.”

51% - strongly agreed

41% - agreed

Regressions - Variable Description

- FE (%) Final Exam mark
- LOWM {0,1} = 1 if (local) student (did Gen Maths in HSC) OR (did 2U Maths only)
- HIGHM {0,1} = 1 if (local) student (did 4U Maths)
- MT (%) Mid-Term exam mark (%)
- QUIZB {0,1} = 1 if student attempted all 4 e-quizzes
- GEN {0,1} = 1 if Female
- INTL {0,1} = 1 if non-local student

Summary Statistics 1

Table 4: Continuous Variable Summary Statistics

	Sample 1		Sample 2	
	FE	MT	FE	MT
n	397	395	1240	1264
mean	0.55	0.47	0.60	0.71
std	0.19	0.17	0.20	0.16
min	0.00	0.10	0.01	0.15
max	0.98	0.90	1.00	1.00

Summary Statistics 2

Table 5: Dummy Variable Summary Statistics

	Sample 1			Sample 2		
	n^a	\bar{x}	s	n^a	\bar{x}	s
FEPASS	397	0.64	0.48	1273	0.69	0.46
GEN *** b	397	0.55	0.50	1273	0.47	0.50
HIGHM ***	198	0.17	0.38	990	0.31	0.46
INTL ***	397	0.35	0.48	1273	0.17	0.37
LOWM ***	198	0.45	0.50	990	0.31	0.46
MTPASS ***	397	0.45	0.50	1273	0.91	0.29
PASSB	397	0.14	0.35	1273	0.15	0.36
QABPASS	368	0.90	0.30	1188	0.89	0.32
QUIZB	397	0.80	0.40	1273	0.83	0.38
STRATC ***	397	0.07	0.25	1189	0.01	0.10
STRATD ***	397	0.09	0.28	1106	0.02	0.15

Do regular online e-quizzes enhance performance? Model 1

- *Model 1: Includes HIGH / LOW maths dummies (so only local students)*

$$FE_i = \beta_0 + \beta_1 QUIZB_i + \beta_2 MT_i + \beta_3 PASSB_i + \beta_4 LOWM_i + \beta_5 HIGH_i + \beta_6 GEN_i + \epsilon_i$$

– (TN: logistic transform applied)

Do regular online e-quizzes enhance performance? Model 2

- *Robustness check ... is this a 'local-only' result?*
- *Model 2: Whole sample (local and non-local) .. no Maths dummies, but INTL dummy added.*

$$FE_i = \beta_0 + \beta_1 QUIZB_i + \beta_2 MT_i + \beta_3 PASSB_i + \beta_4 GEN_i + \beta_5 INTL_i + \epsilon_i$$

Do regular online e-quizzes enhance performance? (Sample 1)

Table 6: Final Examination (%), Sample 1^a

	Local Obs	All Obs ^b
QUIZB	0.48***	0.50***
	(4.06)	(4.99, 4.71)
MT	1.91***	2.63***
	(6.27)	(11.1, 10.21)
PASSB	0.25[†]	0.18[†]
	(1.83)	(1.58, 1.7)
LOWM	-0.34***	-
	(-3.3)	
HIGHM	0.52***	-
	(3.84)	
GEN	0.13	0.05
	(1.43)	(0.62, 0.61)
INTL	-	0.35***
		(4.13, 3.86)
CONSTANT	-1.18***	-1.56***
	(-6.6)	(-11.4, -10.05)

Do regular online e-quizzes enhance performance? (Sample 2)

Table 7: Final Examination (%), Sample 2^a

	LOCAL OBS ^b	ALL OBS ^b
QUIZB	0.44***	0.57***
	(6.94, 6.69)	(9.16, 8.49)
MT	2.76***	3.53***
	(17.58, 17.99)	(24.81, 22.97)
PASSB	-0.03	-0.16***
	(-0.44, -0.49)	(-2.66, -3.02)
LOWM	-0.40***	-
	(-7.09, -7.82)	
HIGHM	0.43***	-
	(7.91, 7.55)	
GEN	0.13***	0.11***
	(2.86, 2.84)	(2.58, 2.52)
INTL	-	0.08*
		(1.40, 1.46)
CONSTANT	-1.91***	-2.58***
	(-15.02, -15.85)	(-24.26, -22.45)

Can online e-quizzes serve as a low-cost warning signal?

- $FEPASS = 1$, if Student passes final exam
- *Local students only (incl. LOW/HIGH maths)*

$$FEPASS_i = \beta_0 + \beta_1 QABPASS_i + \beta_2 MTPASS_i \\ + \beta_3 LOWM_i + \beta_4 HIGHM_i + \beta_5 GEN_i + \epsilon_i$$

– (TN: model estimated as 'true' Logit)

Can online e-quizzes serve as a low-cost warning signal?

Table 8: Probability of Passing the Final Examination

	SAMPLE 1		SAMPLE 2	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect
QABPASS	1.23**	0.30	1.38***	0.28
	(2.23)		(5.24)	
MTPASS	1.13***	0.19	1.52***	0.31
	(3.10)		(4.95)	
LOWM	-0.79**	-0.19	-1.71***	-0.36
	(-2.11)		(-8.88)	
HIGHM	0.77*	0.14	0.74***	0.08
	(1.37)		(2.97)	
GEN	0.65**	0.16	0.35**	0.04
	(1.93)		(2)	
CONSTANT	-1.13**		-1.31***	
	(-1.88)		(-3.28)	

In summary

We have

- Considered a very large, diverse data-set
- Tested hypotheses concerning the benefits of the new course design, especially regarding students' perceived sense of feedback
- Tested hypotheses concerning exposure to e-quizzes in a small (local only) and large (local and non-local) student data-set, on two very different sample sessions

We have also

- Investigated the use of online e-quizzes as a low-cost, early intervention marker for students likely to be in trouble later in the course.

Conclusions

- Strong support (by Chi-squared analysis) for the new course design improving students' sense of feedback and overall enjoyment
- Significant and robust support for the hypothesis that *exposure* (not actual mark) to the online e-quizzes improves student performances, controlling for many factors including prior and current aptitude
- Early administered e-quizzes could be useful as a low-cost early-warning system for 'at-risk' students.