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The Effectiveness of Usage of Online Multiple Choice Questions on Student Performance in Introductory Accounting

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ABSTRACT: In this paper we investigate the effectiveness of an online learning resource for introductory financial accounting students using a suite of online multiple choice questions (MCQ) for summative and formative purposes. We found that the availability and use of an online resource resulted in improved examination performance for those students who actively used the online learning resource. Further, we found a positive relationship between formative MCQ and unit content related to challenging financial accounting concepts. However, better examination performance was also linked to other factors, such as prior academic performance, tutorial participation, and demographics, including gender and attending university as an international student.

Keywords: multiple choice questions; formative assessment; summative assessment; online learning; accounting education.

JEL Classifications: I20; M41.

INTRODUCTION

There has been a trend, especially in Western societies, to move away from paper-based learning materials and toward the use of online learning resources. Many textbook publishers now provide various online resources to complement the textbook or the equivalent electronic version (e-book). "Online learning comes in a dizzying variety of flavors, ranging from simply videotaping lectures and posting them online for anytime access, to uploading materials such as syllabi, homework assignments, and tests to the Internet, all the way to highly sophisticated interactive learning systems that use cognitive tutors and take advantage of multiple feedback loops" (Bowen, Chingos, Lack, and Nygren 2013, 59). Some

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textbook publishers have made various claims that students who use their online resource *do* perform better in examinations. In 2010 J. Wiley & Sons Inc. released a statistical report that suggested, on average, students who used their online resource, WileyPLUS,[1] had significantly better learning outcomes at the end of the course.[2] Consequently, there has been a growing number of researchers who are investigating the usefulness of these online learning resources for student learning.

In many prior studies of online learning, researchers concentrated on learner satisfaction gained from online learning and examined factors that affected student attitudes toward flexible online learning.[3] Other researchers have also investigated online learning environments and their relationship to students' performance.[4] In general, these studies found that online learning can be a useful aid for students. However, in some of these past studies, researchers have used the amount of time that students spend online as the measure of the use of online resources and tested this relationship with student performance. Employing the amount of time spent using online resources may not capture the students' effective use of online resources as students may be using multiple websites at the same time and leaving tabs open indefinitely, with inactive periods combined with active usage periods.

In this study, we contribute to the literature on the usefulness of online learning resources for student learning. In particular, we focus on the effectiveness of the usage of online multiple choice questions (MCQ) on examination performance. We examine students' usage of online MCQ resources for both assessment and revision purposes by examining the relationship of online MCQ used for summative and formative assessment and student examination performance. Our study differs from other papers in that it investigates the effectiveness of online learning resources in introductory accounting for assessment and revision purposes, and whether students' examination performance differs depending on their use of summative and formative assessment. The contribution of our paper is that we quantify the usefulness of online MCQ for both assessment and revision purposes by examining the relationship of online MCQ use for summative and formative assessment and student examination performance.

This paper asks two primary questions. First, what is the effect of providing summative online MCQ to accounting students on their examination performance? Second, what is the effect of providing formative online MCQ to accounting students on their examination performance?

In a first-year introductory financial accounting course (hereafter, the unit) taught at an Australian university in 2014, we examined the usefulness of the WileyPLUS MCQ online resource (hereafter, online MCQ). After including several control variables in the data, we found that, on average, students who voluntarily used online MCQ for formative purposes were able to achieve a higher examination score than those who did not.

The remainder of the paper is organized as follows: we begin with a literature review on the impact of online resources and, in particular, online MCQ and the impact on student learning. This is followed by a section about data selection and the methodology employed in this paper. We then review the empirical findings, and close with a conclusion of the study.

LITERATURE REVIEW

Basioudis and de Lange (2009, 13) commented that "the impact and use of information and communication technology on learning outcomes for accounting students is not well understood." Einig (2013) responded by examining the formative use of MCQ on student performance and found a positive relationship between regular usage and performance in a final examination for an undergraduate accounting course. Other than Einig (2013), limited studies have examined *how* students use MCQs.

Brothen and Wambach (2001) examined the use of online MCQ (which comprised 75 percent of the summative assessment scores) and found a negative correlation between MCQ performance and both the final exam score and total scores for the unit studied. However, this may be explained by the fact that students in this unit could take the MCQ tests many times until they achieved the maximum score for each MCQ test. Also, students could pass the unit solely through the use of MCQ test results; hence, there was little incentive to attempt mastery of the course materials.

[1] WileyPLUS is the brand name for the J. Wiley & Sons Inc. online resource. It is an online comprehensive suite of teaching and learning resources with an automated homework system including MCQ, short answer problem questions, and video tutorials.

[2] J. Wiley & Sons Inc. claim that their online teaching and learning resources help to build students' confidence because it takes the guesswork out of studying by providing a clear roadmap—what to do, how to do it, and whether they did it right. In particular, see the report by Broadview Analytics' (2010) at: https://media.wiley.com/assets/2262/54/WP_Impact_Report_final.pdf/. However, textbook publishers may have overstated the effectiveness of (their) online resources. A study by Bowen et al. (2013) investigated the impact of online learning and found that there was no significant difference in student performance outcomes.

[3] See Drennan, Kennedy, and Pisarski (2005) and Sun, Tsai, Finger, Chen, and Yeh (2008).

[4] See Becker and Dwyer (1994), Dowling, Godfrey, and Gyles (2003), and Kubey, Lavin, and Barrows (2001).

Daniel and Broida (2004) also studied the use of online MCQ and compared students' performance in a mid-semester exam using three groups of students. Two groups did the same MCQ online and in-class, and the third group of students did not do any MCQ. They found students who did the in-class MCQ performed significantly better in the mid-semester exam than both other groups. The students who completed the online MCQ admitted they were able to copy answers. Hence, the researchers adjusted the conditions for the online MCQ and included a large data bank of MCQ so students were randomly allocated different questions. When the performances in the final exam were compared, the researchers found students in both the in-class and online groups had outperformed the no-MCQ group.

Potter and Johnston (2006) tested a specifically developed online interactive system known as MarlinaLS, which included MCQ, on students' performance in the final examination of a major second-year undergraduate accounting subject in an Australian university. The results showed that students' use of MarlinaLS was positively associated with their examination performance. They also found that international students, females, and students who performed well in the preceding accounting subject made greater use of MarlinaLS. Our study differs from Potter and Johnston (2006) as we examine both performance and usage of online MCQ.

Perrin et al. (2011), in a study, compared usage patterns of MCQ under different conditions, which included no contingencies and then contingencies. Under no contingencies, students could access all MCQ for practice before the in-class MCQ test. This was then changed so that access to practice MCQ was contingent on completing the preceding test. Students performed better in the in-class test when contingencies were applied to the practice tests.

In a study at a British university in a management accounting module, Einig (2013) found a positive relationship between regular usage of MCQ and performance in a final examination. Students who attempted at least five sets of MCQ performed better in the final examination. Einig (2013) also found that the use of the online MCQ increased for the better for the students with higher levels of prior academic performance in accounting. Neither gender nor status as international students was significant in the usage of MCQ, and the performance of the international students in the final exam was worse than home-based students (Einig 2013).

Furthermore, Einig (2013) pointed to there being few studies about the impact of MCQ and performance that control for other factors like prior academic performance, gender, and international students, which other researchers have found to be significant in explaining student performance. Our study differs from Einig (2013) in that we examine both performance and usage of online MCQ for summative and formative purposes.

In a study of large undergraduate mathematics units at an Australian university, Angus and Watson (2009) assessed the impact of online quizzes and found that higher engagement with and not score on online MCQ had resulted in higher final exam performance. They also found that whereas prior knowledge, aptitude, and engagement with the online MCQ had a statistically positive and significant impact on final examination performance, the students' status and gender were not significant.

The above literature shows that regular usage of online MCQ for assessment purposes is associated with improved examination performance under differing conditions. Einig (2013) is the only researcher to investigate the impact of formative MCQ on student examination performance and finds improved examination performance for students who attempted the formative MCQ. However, our study seeks to address the gap in the literature identified by Einig (2013) and investigates the impact of MCQ and student examination performance when controlling for other factors including academic performance, gender, and international students. Our study differs from prior research as it explores the impact of MCQ for both summative and formative assessment on student examination performance to investigate how students use MCQ and controls for other factors that are associated with accounting student examination performance.

To sum up, our review of literature indicates that regular usage of MCQ appears to have a positive impact on student performance. Thus, the first two hypotheses we test in this paper are:

H1: There is a positive association between usage of MCQ for summative and formative purposes and the mid-semester examination score.

H2: There is a positive association between performance on MCQ for summative and formative purposes and the mid-semester examination score.

In addition to usage of MCQ, we also test the relationship between the scores on the MCQ and examination performance, and thereby test the following two hypotheses:

H3: There is a positive association between usage of MCQ for summative and formative purposes and the end-of-semester examination score.

H4: There is a positive association between performance on MCQ for summative and formative purposes and the end-of-semester examination score.

DATA SELECTION AND METHODOLOGY

Using the results for first-year students from an Australian university enrolled in an introductory financial accounting unit (the unit) in Semester 2 in 2014,[5] we examined the usefulness of both summative and formative online MCQ. The selection of these students as the sample subjects is appropriate because all Business School students at this university must complete the introductory financial accounting unit, irrespective of their chosen major.[6] Furthermore, this unit is strongly recommended to non-business-degree students as an elective; 48.3 percent of the students sampled were enrolled in a degree other than the Bachelor of Commerce.[7] The WileyPLUS online resources used are based on the prescribed Wiley textbook content and include instructional videos, interactive MCQ, and interactive short answer problem questions.

In this study we only examined the use of the MCQ component of the online learning resource. Access to WileyPLUS was provided free of charge to students enrolled in the unit. Students were strongly encouraged to use WileyPLUS to assist their learning experience, and were informed that the WileyPLUS materials were based on the recommended textbook for the unit.[8] To encourage the use of online MCQ, the unit used ten sets of summative MCQ throughout the academic semester, which represented 5 percent of the total mark for the unit (subject).[9] Each set of summative MCQ comprised MCQ that were based on the assigned readings from the textbook chapters (see Appendix A). Five sets of summative MCQ were related to unit material examined in the mid-semester examination and the remaining five sets of summative MCQ were related to unit material examined in the end-of-semester examination. Students were given one week to complete each summative MCQ, with the MCQ commencing on the Monday evening following the week after the topic was covered in the tutorial. If a student did not attempt a summative MCQ, then he/she was not entitled to access the MCQ after the deadline. Students were also given access to WileyPLUS revision packages that were not included in the summative assessment for the unit. A total of 19 sets of WileyPLUS revision packages comprised entirely of MCQ were made available to the students throughout the academic semester, with eight of the revision packages related to unit content examined in the mid-semester examination and 11 revision packages related to unit content examined in the end-of-semester examination (see Appendix A). The revision packages were made available to the students a week before the relevant examination and there were no restrictions on the use of the revision packages, which allowed students to access and use the revision packages many times.

In this study, we use two proxies to measure students' access of the online MCQ used for summative assessment and one proxy to measure a students' use of the online MCQ for formative purposes. The first is a proxy for students' attempts to complete each of the 10 online MCQ that form part of the summative assessment for the unit. A dichotomous variable (1, 0) is used to proxy for a student's attempt to complete each summative MCQ.[10] The second proxy is the student's individual score for each summative MCQ. An individual MCQ score ranges from 0 to 10 expressed as a percentage. A dichotomous variable (1, 0) is used to proxy a student's revision MCQ usage for formative purposes, which indicates a student's active use of the formative MCQ quiz when compared to the students sampled. Table 1 shows that the number of students attempting the formative MCQ quizzes ranged from 193 to 8 out of the student sample of 424. Therefore, a high proportion of the students sampled did not undertake the formative MCQs.[11] As the revision MCQ were formative, this proxy measured the students' use of the online MCQ by actively engaging with the formative MCQ when compared to their peers for each individual formative MCQ.

In this study, we first collected a list of students who were enrolled in the unit in the second academic semester of 2014. A total of 543 students were enrolled in the unit, which included both domestic and international students. International students may be admitted to the university using either of their Australian Tertiary Admission Rank (ATAR) results or other overseas

[5] The teaching semester for this Australian university runs from the last week of February to the last week of June for Semester 1 and the last week of July to the last week of October for Semester 2. Ethics applications were secured from this Australian university to conduct this study.

[6] Business School students from this Australian university may choose a major from the subjects of accounting, business law, economics, finance, human resource management, management, and marketing.

[7] At this Australian university all undergraduate students must complete a minimum of four units from outside their bachelor degree major. For example, a student majoring in science must complete four units from another faculty within the university other than science, such as arts, commerce, or design.

[8] At this Australian university, textbooks can only be stated as "recommended reading" for a unit. The unit was based on the readings from the recommended textbook with the weekly readings, lectures, and tutorial questions sourced from the recommended textbook.

[9] Each summative MCQ was worth 0.5 percent of a student's unit mark.

[10] A student's attempt is recorded as 1 if the student attempted at least one question from the summative MCQ.

[11] For this study a total of 19 formative MCQ quizzes were released. If all the students sampled completed the formative quizzes, then there would be 8,056 student attempts. However, for our sample only 1,352 student attempts were recorded. Therefore, to measure student's engagement with the formative MCQ, the average score for each formative MCQ quiz was determined for the sample and students who achieved an above-average score for the formative MCQ take the value of 1, and 0 otherwise. For the purposes of our study the *FormativeMCQ* dummy variable identifies those students who are actively using the formative MCQ for revision purposes.

qualifications. Therefore, in order to facilitate a more effective comparison of international students with their domestic counterparts, we eliminated the international students with overseas qualifications.[12] A total of 119 students were eliminated due to the lack of an ATAR score for entrance into the Australian university used in this study, leaving a final sample of 424 students.

To examine whether students who accessed online MCQ for formative purposes performed better than those who did not, an ordinary least squares (OLS) multiple regression analysis is conducted using the following equation:

$$\begin{aligned} \textit{Examination Score}_i = {} & \alpha + \beta_1 \textit{SummativeMCQ}_i + \beta_2 \textit{FormativeMCQ}_i + \beta_3 \textit{ATAR}_i + \beta_4 \textit{Tutorial}_i + \beta_5 \textit{PassDummy} \\ & + \beta_6 \textit{AcctDummy} + \beta_7 \textit{H1MathDummy} + \beta_8 \textit{H2MathDummy} + \beta_9 \textit{PublicSchoolDummy} \\ & + \beta_{10} \textit{DegreeDummy} + \beta_{11} \textit{MajorAcctDummy} + \beta_{12} \textit{Age}_i + \beta_{13} \textit{EnrolmentDummy} \\ & + \beta_{14} \textit{GenderDummy} + \beta_{15} \textit{RuralDummy} + \beta_{16} \textit{InternationalDummy} + \varepsilon_i \end{aligned} \quad (1)$$

Variables that explain student examination performance were entered in two stages. In Stage 1, *Examination Score* (the raw mid-semester or end-of-semester examination score achieved by students expressed as a percentage) is the dependent variable and we regressed it against the *SummativeMCQ:* (1) the dummies for a student's attempt to complete each summative MCQ, and (2) the student's individual score for each summative MCQ. For Stage 1, we omitted the students' usage of online MCQ for formative purposes, but controlled our estimation for a number of independent variables including student ability and engagement, prior education, and environment. The control variables are discussed in detail below.

In Stage 2, we included the use of the online MCQ for formative purposes, the primary focus of this paper, in the Stage 1 estimation. The use of online MCQ for formative purposes was proxied by *FormativeMCQ*, a dichotomous variable (1, 0) that captures a student's active use of the revision MCQs by comparing the students' use when compared to their peers for each individual revision package for formative purposes, using 1 if a student's active use for an individual online formative MCQ was above the mean usage for the students sampled, and 0 otherwise.[13] If students who actively used the online resource performed better than those who did not, then, with other things constant, we expected a statistically significant positive coefficient for the formative MCQ variables.

Control Variables

In our study, we controlled several independent variables, including student ability and engagement, prior education, and demographics. Following Bandura (1986) and Jackling and Anderson (1998), student ability in our study was proxied by the student's university entrance score (*ATAR*).[14] Prior researchers have found a positive association between tutorial attendance and performance (e.g., Rodgers 2002; Romer 1993). Hence, we measure a student's engagement with weekly tutorials by the score achieved for *Tutorial* by the student (measured as a percentage based on student participation and attendance for the 12 tutorial sessions for an academic semester).

Students who are motivated to succeed at the university, may access study assistance programs offered by the university. Those who access assistance may be students who are already confident about their performance and are seeking further improvement in their performance, or they may be students who recognize that they need further assistance to achieve their desired level of performance. In our sample university, students are given the opportunity to participate in a peer-assisted study program (PASS)[15] during their first year accounting studies. As such, we include the dichotomous variable *PASS:* 1 if the student has enrolled and actively attended the PASS program, or 0 otherwise.

Accounting education researchers have found that prior education (such as secondary accounting course or advanced secondary math subjects) has positive impacts upon a student's performance in accounting units at a university (Ramsay and Baines 1994; Rohde and Kavanagh 1996; Alcock, Cockcroft, and Finn 2008). In our study, prior education was measured using a series of dichotomous variables, (1, 0), including past accounting studies (*Acct*) and advanced mathematics studies in

[12] Although the evaluation of international student's overseas qualifications is considered to be comparable for entrance to this university, the conversion of many different overseas qualifications into an equivalent Australian university entrance score, that is an Australian Tertiary Admission Rank (ATAR), is not released by the university and is beyond the scope of our study. Also, a number of international students either complete an Australian-recognized university entrance program to achieve an ATAR in their home country or in Australia to obtain entry into an Australian university undergraduate degree program.

[13] See footnote 11 for the discussion of the *FormativeMCQ* proxy variables and the use of a dichotomous variable (1, 0) of an above-average score for this study.

[14] This Australian university has a minimum entrance ATAR score of 80.00. Since ATAR (maximum 99.95) is a bounded variable, we expressed it as an odds ratio (Greene 2003).

[15] PASS is a peer-facilitated, cooperative student support scheme for students. It gives students enrolled in some of the large core units (such as the unit selected for this study) the opportunity to work collaboratively in small groups with the help of a competent, caring, subject-experienced student peer. The focus is on the group and learning together. PASS consists of 45-minute non-compulsory sessions held weekly and led by trained peer leaders.

secondary education (*H1Math* and *H2Math*). *Acct* is given the value of 1 if a student has completed a secondary school accounting course, and 0 otherwise. The minimum mathematics entry requirement for the university in this study is discrete mathematics. Students who had completed calculus (*H1Math*) or applicable mathematics (*H2Math*) were considered to have higher mathematics skills and the variable is given the value of 1, or 0 otherwise.

The type of secondary school that students attended prior to entering the university may have an impact of their tertiary education. For example, O'Brien and Pianta (2010) demonstrated that private school students outperformed public school students at United States elementary schools. However, it is unclear whether the higher level of performance was attributable to better education provided by private schools, or a selection bias due to the higher socio-economic status (SES) of private school students (Ryan and Watson 2004). Although low SES students are generally under-represented in universities, some low SES students succeed despite the challenges they face. In our study, a dichotomous variable was used to measure the type of secondary school attended, *PublicSchools,*[16] and given the value of 1 if the student's final year of secondary education was at a public school, or 0 otherwise.

The accounting unit used in this study is offered to all students either as a prerequisite for their chosen major, or as a unit toward their degree requirements (see footnote 7). Therefore, students who enrolled in the unit may or may not have been studying commerce. To control for the difference in performance of students who were studying commerce from those students enrolled in another degree, a dichotomous variable for *Degree* was used for arts (*DegreeArts*), commerce (*DegreeComm*), engineering (*DegreeEng*), and science (*DegreeSc*), and given the value of 1 for the degree studied, or 0 otherwise.[17] To control for differences in the majors of study selected by the students, a dichotomous variable was used. Students enrolled in the unit who had selected to study accounting as their major (*MajorAcct*) were expected to perform better than students who did not, and the variable given the value of 1, or 0 otherwise.

Prior researchers have found that age may be related to student performance (Duff 1999, 2004; M. Koh and H. Koh 1999; Bartlett, Peel, and Pendlebury 1993). We controlled for the age of the student, *Age,* calculated in years using the student's date of birth. The demographic differences of university students including type of enrollment, gender, rural background, and attending university as an international student may also have an impact on students' examination performance (Hartnett, Römcke, and Yap 2004; Jackling and Anderson 1998; Ballantine, Duff, and McCourt-Larres 2008; Byrne and Flood 2008; Chickering 1969; Taub 1997; Hartnett et al. 2004; Einig 2013). In our study, these demographic factors were controlled by using a series of dichotomous variables, (1, 0), including: *Enrolment* (1 if the student was a full-time student, 0 otherwise), *Gender* (1 if the student was female, 0 otherwise), *Rural* (1 if the student came from a rural[18] area, 0 otherwise) and *International* (1 if the student was a full-fee paying international student [based on the student's visa], 0 otherwise).

RESULTS AND ANALYSIS

Descriptive statistics

Table 1 presents the variables and their descriptive statistics. Panel A of Table 1 shows that of the students sampled, on average, 70.5 percent of them participated in the ten summative MCQ. The students' participation declined across time for both the summative and formative MCQ. The sequences of the MCQ corresponded with the sitting of the mid-semester or end-of-semester examination papers; the materials tested in the earlier MCQ corresponded with the mid-semester examination paper, whereas the later MCQ were relevant for the end-of-semester examination paper. Interestingly, in Panel B of Table 1, the average mid-semester examination paper score (64.59 percent) was higher than that of the end-of-semester examination paper (48.50 percent).[19] Students' end-of-semester examination performance was further analyzed by the scores for each section of the examination, with an average score of 47.70 percent for the MCQ section and 48.85 percent for the written section.[20] The decline in students' active participation in both the summative and formative MCQ (preparation tools for the end-of-semester examination paper) may have resulted in a lower average for the end-of-semester examination paper. However, the end-of-semester exam is traditionally a more difficult exam, which could be the major reason for the lower scores compared to the mid-

[16] Public schools refer to secondary schools provided by the state government. Private schools refer to independent, Catholic, or bridging secondary school institutions.

[17] During the sample period, the students were enrolled in four different degree programs at the university.

[18] Rural addresses are identified as having Australian post codes 6215–6646, 6701, and 6799.

[19] The mid-semester examination was comprised of 50 multiple-choice questions, worth 50 points. The end-of-semester examination was comprised of 30 multiple-choice questions, worth 30 points, and eight short answer questions worth 70 points.

[20] In an unreported analysis, the average end-of-semester examination MCQ section score for students who actively participated in the voluntary MCQ was 58.12 percent, whereas those who did not actively participate in the voluntary MCQ was 42.72 percent. The average difference of 15.40 percent was statistically significant at the 1 percent level.

TABLE 1

Descriptive Statistics

Panel A: WileyPLUS Usage

WileyPLUS Usage										
WileyPLUS *SummativeMCQ*										
MCQ number	1	2	3	4	5	6	7	8	9	10
Number of students attempted	352	322	321	355	320	270	268	274	272	235
Proportion attempted	83.0%	75.9%	75.7%	83.7%	75.4%	63.7%	63.2%	64.6%	64.1%	55.4%
Average	7.2	5.7	5.1	6.7	6.3	5.1	4.4	5.1	4.9	4.4
(Std. Dev.)	(3.4)	(3.4)	(3.2)	(3.3)	(3.8)	(4.0)	(3.6)	(3.9)	(3.9)	(4.1)
WileyPLUS *FormativeMCQ*										
MCQ number	1	2	3	4	5	6	7	8	9	10
Number of students attempted	193	149	122	128	8	69	117	113	61	64
Proportion attempted	45.5%	35.1%	28.8%	30.2%	1.9%	16.3%	27.6%	26.6%	14.4%	15.1%
Number of students attempted and above-average score	171	135	113	112	8	67	105	99	58	59
Proportion above average	40.3%	31.8%	26.6%	26.4%	1.8%	15.8%	24.7%	23.3%	13.6%	13.9%
WileyPLUS *FormativeMCQ*										
MCQ number	11	12	13	14	15	16	17	18	19	
Number of students attempted	53	45	22	28	36	35	30	39	40	
Proportion attempted	12.5%	10.6%	5.2%	6.6%	8.5%	8.3%	7.1%	9.2%	9.4%	
Number of students attempted and above-average score	50	44	22	28	36	32	30	36	40	
Proportion above average	11.8%	10.3%	5.2%	6.6%	8.5%	7.5%	7.1%	8.5%	9.4%	

Panel B: Continuous Variables

Variable	**Variable Group**	**Description**	**All Students Average (Std. Dev.)**
Mid-semester examination score (*MSE*)	Dependent variable	Students' raw mid-semester examination score expressed as a percentage.	64.59 (18.75)
End-of-semester examination score—full examination (*ESE*)	Dependent variable	Student's raw end-of-semester examination score expressed as a percentage.	48.50 (20.25)
End-of-semester examination score—MCQ Section (*ESEMCQ*)	Dependent variable	Student's raw end-of-semester examination score for the MCQ section expressed as a percentage.	47.70 (17.97)
End-of-semester examination score—written section (*ESEW*)	Dependent variable	Student's raw end-of-semester examination score for the written section expressed as a percentage.	48.85 (26.67)
ATAR	Student ability and engagement	Students' university entrance score (ATAR) expressed as an odds ratio.	1.00 (0.54)
Tutorial	Student ability and engagement	Tutorial mark achieved by the student during the semester expressed as a percentage.	88.27 22.26
PASS intensity	Student ability and engagement	Students who enrolled and attended the PASS program weighted by the number of sessions attended over the number of available sessions for the semester.	2.67 (12.57)
Age	Demographics	Student age calculated based on the year in which they were enrolled in the course.	19.18 (1.55)

(continued on next page)

TABLE 1 (continued)

Panel C: Dichotomous Variables

Variable	Variable Group	Description	n	%
PASS	Student ability and engagement	Students who enrolled and attended the university PASS program = 1, 0 otherwise.	26	6.1
Acct	Prior education	Students who completed accounting studies in secondary education = 1, 0 otherwise.	54	12.7
H1Math	Prior education	Students who completed calculus in secondary education = 1, 0 otherwise.	132	31.1
H2Math	Prior education	Students who completed applied mathematics in secondary education = 1, 0 otherwise.	180	42.4
PublicSchool	Prior education	Students who previously attended a public school = 1, 0 otherwise.	101	23.8
DegreeArts	Demographics	Students enrolled in a Bachelor of Arts program = 1, 0 otherwise.	31	7.3
DegreeComm	Demographics	Students enrolled in a Bachelor of Commerce program = 1, 0 otherwise.	219	51.7
DegreeEng	Demographics	Students enrolled in a Bachelor of Engineering program = 1, 0 otherwise.	18	4.2
DegreeSc	Demographics	Students enrolled in a Bachelor of Science program = 1, 0 otherwise.	156	36.8
MajorAcct	Demographics	Students enrolled in an accounting major = 1, 0 otherwise.	68	16.0
Enrolment	Demographics	Students enrolled on a full-time basis (with an aggregate "equivalent full-time student unit" for all units of study more than 0.75) = 1, 0 otherwise.	407	95.9
Gender	Demographics	Female students = 1, 0 otherwise.	155	36.5
Rural	Demographics	Students' home address outside the capital city or surrounding suburbs = 1, 0 otherwise.	26	6.1
International	Demographics	Students who are attending the university on a student visa = 1, 0 otherwise.	68	16.0

This table presents the descriptive statistics of the dependent, test, and control variables examined in this study.
Panel A reports the suite of WileyPLUS MCQ available for the unit for the sample. The WileyPLUS *SummativeMCQ* are the weekly MCQ released throughout the semester that were included in the students' overall unit mark. The WileyPLUS *FormativeMCQ* are the chapter revision MCQ that were released throughout the semester for student revision purposes.
Panel B reports the descriptive statistics for the continuous variables for the sample.
Panel C reports the descriptive statistics for the dichotomous variables for the sample.

semester examination. The decline in the usage of the online MCQ has also been found in other studies (e.g., Henly 2003; Catterall and Ibbotson 1995).

Panels B and C of Table 1 present the summary statistics for both the continuous and dichotomous variables. The student ability control variables show that the average *ATAR* score was 87.08[21] (odds ratio of 1.00). Given the minimum *ATAR* entrance score set at 80.00 for the university studied in this paper, the average *ATAR* score for the unit was not surprising. The demographic control variables showed that the degree studied by the students varied, with 7.3 percent completing a Bachelor of Arts, 51.7 percent completing a Bachelor of Commerce, 4.2 percent completing a Bachelor of Engineering, and 36.8 percent completing a Bachelor of Science. These results were not surprising given the university requirement for students to study a selection of units outside of their chosen major. Although over half of the students enrolled in the unit were undertaking a Bachelor of Commerce, only 16.0 percent of the students sampled had nominated an accounting major.

Table 2 presents the Pearson correlation coefficients for the continuous variables. Although most of the correlation coefficients were positive and significant at the 1 percent level, recall that the continuous variables mainly represented examination performance scores, that is, the summative MCQ scores and the student ability and engagement control variables of *ATAR* and *Tutorial* scores, which were all measures of student performance. These results give some insight into the expected multiple regression results and there are no significant collinearity issues between the variables.

Test of Hypotheses

Table 3 presents the results from the OLS multiple regressions. Columns (a) and (b) of Table 3 report the findings for summative MCQ attempts, whereas Columns (c) and (d) report the findings for summative MCQ scores in Stages (1) OLS without the formative MCQ proxy variables, and (2) OLS with the formative MCQ proxy variables of the regressions, respectively.

[21] *ATAR* scores increase in increments of 0.05 to a maximum of 99.95. The average *ATAR* score of 87.08 is between the actual *ATAR* scores of 87.10 and 87.05.

TABLE 2
Correlation Coefficient Matrix

Panel A: Dependent and Test Variables

	MSE	*ESE*	*ESEMCQ*	*ESEW*	*MCQ 1*	*MCQ 2*	*MCQ 3*	*MCQ 4*	*MCQ 5*	*MCQ 6*	*MCQ 7*	*MCQ 8*	*MCQ 9*	*MCQ 10*
MSE	1.000													
ESE	0.696***	1.000												
ESEMCQ	0.619***	0.859***	1.000											
ESEW	0.678***	0.985***	0.756***	1.000										
MCQ 1	0.393***	0.413***	0.363***	0.404***	1.000									
MCQ 2	0.399***	0.401***	0.335***	0.398***	0.517***	1.000								
MCQ 3	0.327***	0.366***	0.289***	0.369***	0.473***	0.506***	1.000							
MCQ 4	0.441***	0.442***	0.404***	0.427***	0.489***	0.575***	0.536***	1.000						
MCQ 5	0.437***	0.483***	0.427***	0.472***	0.560***	0.521***	0.523***	0.713***	1.000					
MCQ 6	0.328***	0.353***	0.329***	0.338***	0.374***	0.419***	0.414***	0.522***	0.504***	1.000				
MCQ 7	0.307***	0.384***	0.328***	0.379***	0.432***	0.476***	0.442***	0.571***	0.573***	0.496***	1.000***			
MCQ 8	0.326***	0.440***	0.333***	0.448***	0.398***	0.465***	0.520***	0.555***	0.567***	0.475***	0.582***	1.000		
MCQ 9	0.363***	0.440***	0.355***	0.442***	0.412***	0.455***	0.519***	0.591***	0.602***	0.524***	0.611***	0.671***	1.000	
MCQ 10	0.354***	0.418***	0.300***	0.431***	0.391***	0.433***	0.462***	0.492***	0.560***	0.499***	0.558***	0.637***	0.743***	1.000
ATAR	0.412***	0.416***	0.378***	0.403***	0.139***	0.113***	0.027	0.087**	0.189***	0.129***	0.131***	0.120***	0.155***	0.156***
Tutorial	0.443***	0.550***	0.490***	0.536***	0.396***	0.412***	0.311***	0.460***	0.418***	0.334***	0.370***	0.370***	0.402***	0.398***
Age	−0.040	−0.080	−0.088	−0.072	−0.143	−0.039	−0.003	−0.016	−0.129	−0.054	−0.076	−0.062	−0.038	−0.087

Panel B: Control Variables

	ATAR	*Tutorial*	*Age*
ATAR	1.000		
Tutorial	0.148***	1.000	
Age	−0.217	−0.052	1.000

***, **, * Denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.
This table reports the Pearson correlation coefficients for the continuous dependent and independent variables for the sample. *MCQ 1* to *MCQ 10* are the summative MCQ scores for each quiz released. All other variables are defined in Table 1.

TABLE 3

Determinants of Mid-Semester Examination Score

	(a) (Stage 1) *MSE* n = 424	(b) (Stage 2) *MSE* n = 424	(c) (Stage 1) *MSE* n = 424	(d) (Stage 2) *MSE* n = 424
Constant	−0.034	0.019	−0.017	0.029
	(0.134)	(0.135)	(0.134)	(0.136)
MCQ 1	0.039	0.033	0.054	0.045
	(0.026)**	(0.026)	(0.029)**	(0.028)**
MCQ 2	0.032	0.028	0.048	0.042
	(0.018)**	(0.018)**	(0.023)**	(0.023)**
MCQ 3	0.019	0.027	0.002	0.012
	(0.020)	(0.020)*	(0.027)	(0.027)
MCQ 4	0.018	0.015	0.079	0.069
	(0.028)	(0.028)	(0.031)***	(0.032)***
MCQ 5	0.047	0.031	0.031	0.020
	(0.023)**	(0.023)*	(0.028)	(0.029)
FormativeMCQ 1		0.013		0.011
		(0.021)		(0.021)
FormativeMCQ 2		−0.011		−0.014
		(0.025)		(0.024)
FormativeMCQ 3		0.006		0.008
		(0.022)		(0.021)
FormativeMCQ 4		0.050		0.045
		(0.020)***		(0.019)***
FormativeMCQ 5		0.108		0.095
		(0.027)***		(0.028)***
FormativeMCQ 6		0.008		0.007
		(0.021)		(0.020)
FormativeMCQ 7		0.006		0.006
		(0.021)		(0.020)
FormativeMCQ 8		−0.005		−0.004
		(0.022)		(0.002)
ATAR	0.136	0.127	0.126	0.119
	(0.015)***	(0.016)***	(0.016)***	(0.016)***
Tutorial	0.212	0.203	0.186	0.184
	(0.046)***	(0.046)***	(0.047)***	(0.047)***
PASS	−0.052	−0.049	−0.054	−0.049
	(0.051)	(0.05)	(0.050)	(0.053)
Acct	0.095	0.085	0.091	0.083
	(0.020)***	(0.020)***	(0.020)***	(0.020)***
H1Math	0.009	0.009	0.012	0.012
	(0.021)	(0.021)	(0.021)	(0.020)
H2Math	0.003	0.000	0.004	0.001
	(0.020)	(0.020)	(0.020)	(0.020)
PublicSchool	0.005	−0.006	−0.001	−0.010
	(0.018)	(0.018)	(0.017)	(0.018)
DegreeArts	−0.007	−0.014	−0.004	−0.011
	(0.035)	(0.036)	(0.034)	(0.035)
DegreeEng	0.089	0.085	0.078	0.076
	(0.037)***	(0.037)***	(0.037)**	(0.036)***
DegreeSc	0.016	0.014	0.013	0.012
	(0.017)	(0.017)	(0.017)	(0.017)
MajorAcct	0.071	0.064	0.070	0.064
	(0.021)***	(0.020)***	(0.021)***	(0.020)***
Age	0.008	0.007	0.008	0.007

(continued on next page)

TABLE 3 (continued)

	(a) (Stage 1) *MSE* n = 424	(b) (Stage 2) *MSE* n = 424	(c) (Stage 1) *MSE* n = 424	(d) (Stage 2) *MSE* n = 424
	(0.006)*	(0.006)	(0.006)*	(0.006)
Enrolment	0.039	0.041	0.041	0.042
	(0.030)*	(0.031)*	(0.029)*	(0.030)*
Gender	−0.012	−0.015	−0.011	−0.015
	(0.015)	(0.015)	(0.014)	(0.014)
Rural	−0.005	−0.008	−0.011	−0.012
	(0.026)	(0.025)	(0.024)	(0.024)
International	0.025	0.019	0.008	0.005
	(0.028)	(0.027)	(0.028)	(0.028)
R^2	0.451	0.478	0.471	0.491
Adj. R^2	0.422	0.439	0.444	0.454
F-Statistics	15.723***	12.450***	17.099***	13.154***

***, **, * Denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.
This table shows mid-semester examination (*MSE*) scores for the students sampled and reports the coefficients of the OLS multiple regression, which take the form of:

$$ExaminationMark_i = \alpha + \beta_1 SummativeMCQ_i + \beta_2 FormativeMCQ_i + \beta_3 ATAR_i + \beta_4 Tutorial_i + \beta_5 PASSDummy + \beta_6 AcctDummy + \beta_7 H1MathDummy + \beta_8 H2MathDummy + \beta_9 PublicSchoolDummy + \beta_{10} DegreeDummy + \beta_{11} MajorAcctDummy + \beta_{12} Age_i + \beta_{13} EnrolmentDummy + \beta_{14} GenderDummy + \beta_{15} RuralDummy + \beta_{16} InternationalDummy + \varepsilon_i \quad (1)$$

In Columns (a) and (b), the *MCQ 1* to *MCQ 5* are the dummies for the *SummativeMCQ* attempt for each quiz released, whereas in Columns (c) and (d), the *MCQ 1* to *MCQ 5* are the *SummativeMCQ* score for each quiz released. *FormativeMCQ 1* to *FormativeMCQ 8* are dichotomous variables (1, 0) that indicate a student achieving an above average score for each quiz released. The standard errors are in parentheses.
All other variables are defined in Table 1.

Hypothesis 1

There is a positive association between usage of MCQ for summative and formative purposes and the mid-semester examination score.

In Column (a) of Table 3, students performed better in their mid-semester examination paper if they attempted the summative *MCQ 1, MCQ 2,* and *MCQ 5*; all were statistically significant at 5 percent after controlling for the independent variables. In Column (b) of Table 3 we added the formative MCQ attempts into the regression. We continued to find that students performed better in their mid-semester examination paper if they had attempted the summative MCQ (*MCQ 2*, *3,* and *5*); all were statistically significant between the 5 percent and 10 percent levels. However, we further found that students who voluntarily and actively attempted the formative MCQ (*FormativeMCQ 4* and *FormativeMCQ 5*) obtained a higher mid-semester examination score. *FormativeMCQ 4* and *FormativeMCQ 5* cover the difficult topics of adjusting the accounts and preparing financial statements (see Appendix A). The R^2 for Stage 1, Column (a), the summative MCQ, was 42.2 percent, and increased to 43.9 percent for Stage 2, Column (b), the summative and formative MCQ. The results show that H1 was supported because the predictor variables, *FormativeMCQ*, contributed to the overall relationship with the dependent variable.[22]

Hypothesis 2

There is a positive association between performance on MCQ for summative and formative purposes and the mid-semester examination score.

[22] In an unreported analysis, the average mid-semester examination score for students who actively participated in the voluntary MCQ was 71.2 percent, whereas those who did not actively participate in the voluntary MCQ was 59.0 percent. The average difference of 12.2 percent was significant at the 1 percent level.

The summative MCQ attempts only capture the attempts of the students (Table 3, Columns (a) and (b)). We re-ran our regression by replacing the summative MCQ attempts with summative MCQ scores (Table 3, Columns (c) and (d)). The latter regression measured students' performance rather than merely their participation; a student may not have been sufficiently enticed by the 5 percent weightage of the summative MCQ. Some students may have deemed the 5 percent not worth their time and may not have put in a real effort to attempt the summative MCQ. In Column (c) of Table 3, the summative MCQ scores show that students performed better in their mid-semester exam if they had attempted and scored well for *MCQ 1*, *MCQ 2,* and *MCQ 4* (the coefficients range from 0.048–0.079 and are all statistically significant between the 1 percent and 5 percent levels). The same coefficients remained statistically significant when we added the *FormativeMCQ* attempts in Column (d). More importantly, similar to previous results, the results in Column (d) showed that students who achieved above the average score in *FormativeMCQ 4* and *FormativeMCQ 5* achieved a better mid-semester examination result; the positive coefficients of 0.045 and 0.095, respectively, were both statistically significant at the 1 percent level. Recall that these *FormativeMCQ* covered the topic of adjusting the accounts and preparing financial statements (see Appendix A). The R^2 for Stage 1, Column (c), the summative MCQ, was 44.4 percent, and increased to 45.4 percent for Stage 2, Column (d), the summative and formative MCQ. The results show that H2 was supported because the predictor variables, *FormativeMCQ*, contributed to the overall relationship with the dependent variable.

In all the columns of Table 3, we found that the control variables for student ability of *ATAR* and *Tutorial,* prior education of *Acct,* and the demographics of *DegreeEng, MajorAcct,* and *Enrolment* also had positive and significant coefficients.

Hypothesis 3

There is a positive association between usage of MCQ for summative and formative purposes and the end-of-semester examination score.

Next, we extended our analyses to examine whether the use of online MCQ had any impact on the students' end-of-semester examination scores. Table 4 presents the results for the end-of-semester examination score, which was comprised of both the MCQ and written answer questions.

Similar to the results in Table 4, students who attempted the summative MCQ (Stage 1, Column (a)) tended to achieve a higher end-of-semester examination score, particularly for *MCQ 8* with coefficients in the range of 0.047 to 0.077, statistically significant at the 1 percent level. When added with the voluntary attempts (Stage 2, Column (b)), we continued to find that students who attempted the *FormativeMCQ* achieved even higher scores (other things being constant) for their end-of-semester examination scores. Some of the summative MCQ were statistically significant for some of the regression results, but not for others. For example, *MCQ 7* with a coefficient of 0.030 was statistically significant at the 10 percent level, but only for Stage 2, Column (b). Also, *MCQ 6*, with coefficients in the range of 0.026 to 0.033, was statistically significant at the 10 percent to 5 percent level for Stage 1, Column (a), and Stage 2, Column (b), respectively.

Again, we found that the students who voluntarily and actively attempted the formative MCQ (*FormativeMCQ 9* and *FormativeMCQ 10*) obtained a higher end-of-semester examination score (Stage 2, Column (b)). For *FormativeMCQ 9*, which covered the theoretical topics of regulation and the conceptual framework, both were statistically significant at the 1 percent level. The results for *FormativeMCQ 10* were both statistically significant at the 5 percent level and the MCQ covered the topics of cash management and control. For the end-of-semester examination results, we found that students who attempted voluntary MCQ that covered more theoretical-based topics tended to perform better in their final exam. The R^2 for Stage 1, Column (a), the summative MCQ, was 50.1 percent, and increased to 51.7 percent for Stage 2, Column (b), the summative and formative MCQ. The results showed that H3 was supported as the predictor variables, *FormativeMCQ*, contributed to the overall relationship with the dependent variable.

The Table 4 results for the control variables remain similar to that in Table 3 for *ATAR, Tutorial, Acct, MajorAcct,* and *Enrolment*. Students who were studying an arts degree did not perform as well as students who were studying a commerce degree, with *DegreeArts* coefficients in the range of −0.030 to −0.036 and statistically significant ranging between 5 percent and 10 percent levels for Columns (b), (c) and (d), respectively. Interestingly, we found that female student performance in the end-of-semester examination was significantly inferior to male student performance. International students performed better in the end-of-semester examination than other students.

Hypothesis 4

There is a positive association between performance on MCQ for summative and formative purposes and the end-of-semester examination score.

Similar to the mid semester results we re-ran our regression for the end-of-semester scores by replacing the summative MCQ attempts with summative and formative MCQ scores. Again, we found a significant and positive relationship between the

TABLE 4

Determinants of End-of-Semester Examination Score
Full Examination

	(a) (Stage 1) *ESE* n = 424	(b) (Stage 2) *ESE* n = 424	(c) (Stage 1) *ESE* n = 424	(d) (Stage 2) *ESE* n = 424
Constant	−0.257	−0.217	−0.247	−0.213
	(0.129)**	(0.128)*	(0.128)**	(0.128)*
MCQ 6	0.026	0.033	0.024	0.031
	(0.020)*	(0.019)**	(0.023)	(0.023)*
MCQ 7	0.027	0.030	0.016	0.021
	(0.023)	(0.022)*	(0.027)	(0.027)
MCQ 8	0.047	0.048	0.077	0.077
	(0.022)***	(0.021)***	(0.028)***	(0.027)***
MCQ 9	0.000	0.000	0.022	0.022
	(0.025)	(0.025)	(0.035)	(0.036)
MCQ 10	0.005	−0.015	0.002	−0.022
	(0.024)	(0.025)	(0.031)	(0.032)
FormativeMCQ 9		0.067		0.069
		(0.026)***		(0.026)***
FormativeMCQ 10		0.056		0.047
		(0.029)**		(0.028)**
FormativeMCQ 11		−0.027		−0.030
		(0.033)		(0.032)
FormativeMCQ 12		−0.020		−0.016
		(0.033)		(0.033)
FormativeMCQ 13		0.005		0.008
		(0.029)		(0.027)
FormativeMCQ 14		−0.012		−0.004
		(0.033)		(0.032)
FormativeMCQ 15		0.030		0.030
		(0.043)		(0.043)
FormativeMCQ 16		−0.030		−0.033
		(0.038)		(0.040)
FormativeMCQ 17		0.020		0.017
		(0.047)		(0.048)
FormativeMCQ 18		0.012		0.009
		(0.031)		(0.030)
FormativeMCQ 19		0.019		0.015
		(0.024)		(0.024)
ATAR	0.138	0.130	0.129	0.124
	(0.018)***	(0.020)***	(0.018)***	(0.020)***
Tutorial	0.362	0.350	0.358	0.347
	(0.040)***	(0.040)***	(0.040)***	(0.039)***
PASS	−0.012	−0.037	−0.016	−0.039
	(0.048)	(0.044)	(0.047)	(0.045)
Acct	0.105	0.099	0.102	0.097
	(0.023)***	(0.024)***	(0.023)***	(0.024)***
H1Math	0.023	0.020	0.026	0.023
	(0.025)	(0.025)	(0.024)	(0.025)
H2Math	0.019	0.026	0.022	0.028
	(0.021)	(0.021)	(0.021)	(0.021)*
PublicSchools	0.008	0.000	0.005	−0.001
	(0.018)	(0.018)	(0.018)	(0.018)
DegreeArts	−0.026	−0.033	−0.030	−0.036
	(0.024)	(0.023)*	(0.023)*	(0.022)**

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TABLE 4 (continued)

	(a) (Stage 1) *ESE* n = 424	(b) (Stage 2) *ESE* n = 424	(c) (Stage 1) *ESE* n = 424	(d) (Stage 2) *ESE* n = 424
DegreeEng	0.018	0.015	0.013	0.012
	(0.052)	(0.051)	(0.054)	(0.052)
DegreeSc	0.014	0.018	0.013	0.017
	(0.017)	(0.017)	(0.017)	(0.017)
MajorAcct	0.054	0.053	0.050	0.050
	(0.022)***	(0.022)***	(0.022)***	(0.022)***
Age	0.006	0.005	0.006	0.005
	(0.006)	(0.006)	(0.006)	(0.006)
Enrolment	0.066	0.051	0.062	0.049
	(0.035)**	(0.035)*	(0.036)**	(0.037)*
Gender	−0.025	−0.026	−0.021	−0.023
	(0.015)**	(0.015)**	(0.015)*	(0.015)*
Rural	0.034	0.029	0.038	0.034
	(0.028)	(0.030)	(0.027)*	(0.028)
International	0.051	0.053	0.044	0.048
	(0.028)**	(0.028)**	(0.028)**	(0.028)**
R^2	0.525	0.553	0.535	0.559
Adj. R^2	0.501	0.517	0.511	0.523
F-Statistics	21.189***	15.144***	22.017***	15.517***

***, **, * Denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.
This table shows end-of-semester examination (*ESE*) scores—full examination, for the students sampled and reports the coefficients of the OLS multiple regression, which take the form of:

$$ExaminationMark_i = \alpha + \beta_1 SummativeMCQ_i + \beta_2 FormativeMCQ_i + \beta_3 ATAR_i + \beta_4 Tutorial_i + \beta_5 PASSDummy + \beta_6 AcctDummy + \beta_7 H1MathDummy + \beta_8 H2MathDummy + \beta_9 PublicSchoolDummy + \beta_{10} DegreeDummy + \beta_{11} MajorAcctDummy + \beta_{12} Age_i + \beta_{13} EnrolmentDummy + \beta_{14} GenderDummy + \beta_{15} RuralDummy + \beta_{16} InternationalDummy + \varepsilon_i \quad (1)$$

In Columns (a) and (b), the *MCQ 6* to *MCQ 10* are the dummies for the *SummativeMCQ* attempt for each quiz released, whereas in Columns (c) and (d), the *MCQ 6* to *MCQ 10* are the *SummativeMCQ* scores for each quiz released. *FormativeMCQ 9* to *FormativeMCQ 19* are dichotomous variables (1,0) that indicate a student achieving an above average score for each quiz released. The standard errors are in parentheses.
All other variables are defined in Table 1.

scores on formative MCQ (*FormativeMCQ 9* and *FormativeMCQ 10*) and the end-of-semester examination score (Stage 2, Column (d)). The R^2 for Stage 1, Column (c), the summative MCQ, was 51.1 percent, and increased to 52.3 percent for Stage 2, Column (d), the summative and formative MCQ, respectively. The results showed that H4 was supported as the predictor variables, *SummativeMCG* and *FormativeMCQ,* contributed to the overall relationship with the dependent variable.

Hypotheses 3 and 4: Further Tests

Because the end-of-semester examination score comprised two different sections, MCQ and short answer written questions, we further analyzed the end-of-semester examination score by the score achieved for each section. Recall that the online materials included only MCQ, therefore analyzing the results by each end-of-semester examination section may contribute to our understanding of the usefulness of online learning resources for summative and formative purposes in accounting education. We do not report the detailed results in this paper, but offer a few observations below.

One difference we found was that the summative MCQ results for the end-of-semester examination score MCQ section differed from the results for Table 4 in respect of summative *MCQ 6* and *MCQ8*. In Table 4, *MCQ 6* was marginally significant but was highly statistically significant and positive across all the regression results when regressed against the MCQ component of the end-of-semester examination. The results for *MCQ 8* were not significant for the MCQ section but were statistically

significant at the 1 percent level for the written section. Recall that *MCQ 6* covered the more challenging theoretical topics of regulation and the conceptual framework and *MCQ 8* covered receivables and inventories.

In terms of the formative MCQs, the results for *FormativeMCQ 9* is highly positively significant for both the MCQ and written sections of the end-of-semester examination score. For *FormativeMCQ 9,* which covered the theoretical topics of regulation and the conceptual framework, all were statistically significant at the 1 percent level. The results for *FormativeMCQ 10* were statistically significant only for the written section of the end-of-semester exam. *FormativeMCQ 10* covered the topics of cash management and control.

For the end-of-semester examination results for the written section, we found that students who attempted formative MCQ that covered more theoretical-based topics tended to perform better in their final exam. The result for *FormativeMCQ 10* also suggested that the written section examination results were driving the end-of-semester examination result.

CONCLUSIONS AND IMPLICATIONS

Our paper has extended the work of Einig (2013) by examining the use of both summative and formative MCQ and their effect on performance in examinations.

A recent study by Hahn, Fairchild, and Dowis (2013) explored the use of an online homework manager and an intelligent tutoring system, but found no positive relationship between the use of either and final examination scores. Another study by Bowen et al. (2013) found no difference in performance between students who had a traditional face-to-face course compared to a hybrid of face-to-face and computer-aided instruction. In contrast, Einig (2013) found a positive relationship between regular use of MCQ and performance in a final examination.

Similar to Einig (2013) we found that students who actively made use of the WileyPLUS online MCQ performed better in the mid-semester and end-of-semester examinations than students who did not. Our evidence supports the WileyPLUS textbook publishers' claim that students who enrolled in their online resource did perform better in examinations.

Another finding of our study is the significant and positive relationship between *FormativeMCQ* and the content related to conceptually challenging concepts, such as the accounting conceptual framework and the regulation of accounting in Australia. The positive finding applied to both the MCQ and written components of the end-of-semester examination. This provides some support for the assertion that formative assessment encourages a deeper approach to learning—at least for conceptually challenging concepts. The implications of this finding for accounting teachers is that they should endeavor to provide opportunities for formative assessment in all areas of the curriculum and especially the more conceptually challenging areas in introductory accounting courses.

We also controlled for several independent variables known to have an association with exam performance, as recommended by Einig (2103). We found that improved examination performance was supported by the use of WileyPLUS, and we also found that improved examination performance was linked to other independent variables. The results for both the mid-semester and end-of-semester examinations were similar. Academic performance, previous studies of accounting, attending and performing well in tutorial classes were all significantly positively related to examination scores. International students also performed significantly better in the end-of-semester examination than did domestic students. Interestingly, we found that female student performance in the end-of-semester examination was below male student performance and students who studied full-time performed better than part-time students.

Consistent with other studies, we also found a declining use of online MCQ as the semester progressed. This may well be explained by increasing demands on students' time as assignments became due in other units and they needed to prepare for exams across a number of units. Better management of assessments and due dates in other units may help to avoid this decline.

Our findings may be resourceful for accounting teachers in planning their course curriculum. We have shown that providing access to, and encouraging or requiring the use of online resources has the potential to improve student learning outcomes. Teachers should also take note of the findings of Khanlarian and Singh (2014): online resources are more likely to be used when students are familiar with and can easily access them.

The results of this study may also be relevant for student course advisors and teaching staff who provide advice about improving student performance. For example, the benefits of completing voluntary online MCQ, combined with attending and engaging in tutorial assessments, should be emphasized to students.

We acknowledge that our results may not be generalizable across other student cohorts. Future researchers could replicate this study, or extend it by examining student characteristics and the use of formative MCQ, the extent and type of resources used by students if more sophisticated information is available, such as length of active time spent on the MCQ, and access to other resources aside from the MCQ. They may also choose to test the impact of online learning resources on particular types of exam questions rather than the aggregate examination score.

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APPENDIX A

Online MCQ and Textbook Chapters

Textbook Chapter	Chapter Title	*Summative MCQ*	*Formative MCQ*
1	Decision making and the role of accounting	1	1
2	Financial statements for decision making	1	2
3	Recording transactions	1	3
4	Adjusting the accounts and preparing financial statements	4	4, 5
5	Completing the accounting cycle	5	6
6	Accounting for retailing	2	7
7	Accounting systems	3	8
MID SEMESTER			
10	Regulation and the conceptual framework	6	9
11	Cash management and control	7	10
12	Receivables	8	11
13	Inventories	8	12
14	Non-current assets: acquisition and depreciation	9	13, 14
15	Non-current assets: revaluation, disposal, and other aspects	9	15
16	Liabilities	10	16
17	Presentation of financial statements	10	17
18	Cash flow statements	7	18
19	Analysis and interpretation of financial statements	10	19

This appendix presents the chapter number and chapter title used in the textbook for the unit and the corresponding *SummativeMCQ* and *FormativeMCQ* released to the students.