

OPTIONAL FORMATIVE ASSESSMENT AND CLASS ATTENDANCE: THEIR IMPACT ON STUDENT PERFORMANCE

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ABSTRACT

This study investigates the impact of class attendance and the use of optional formative assessment tasks on student performance. We hypothesise that a positive relationship exists between students' attendance rates and their success on assessment tasks. We also hypothesise a positive relationship between the extent to which students use formative assessment tasks (in the form of on-line multiple-choice question sets) and their success on summative assessment tasks. The question of whether attendance and the use of formative assessment have a complementary or substitutional impact on results is also investigated. The results indicate that after controlling for other factors likely to affect student performance, attendance at class and use of on-line formative assessment tasks do affect student performance. However, there is no further synergistic performance improvement to be achieved from both being a good attendee and a high user of the self-assessment quizzes.

Further, attendance and self-assessment opportunities do not act as substitutes for each other. That is, students cannot compensate for poor attendance by making greater use of the self- assessment opportunities and vice versa.

Key words: formative assessment, summative assessment, attendance

Data availability: Data are available on request from the third author.

INTRODUCTION

Traditionally, universities have delivered undergraduate programs in a structured teaching and learning environment. Typically, this involves attendance at scheduled classes, usually both large group lectures and smaller tutorial or workshop groups. There is an expectation that time outside class will be spent by students engaging in reading and assignment work, some of which is assessed as part of the overall determination of a student's grade. Increasingly though, universities have been adopting on-line delivery platforms such as Web-CT and Blackboard to supplement or replace traditional delivery modes. The use of these platforms can range from simply duplicating resources available in the classroom, to providing discussion arenas and links to additional on-line information and assessment, through to delivering courses completely on-line.

The School of Accounting and Finance at the University of Tasmania first introduced on-line learning platforms in 1999, and now all of the courses in the accounting major are supported by Web-CT. Although the extent to which Web-CT is used varies from course to course, it is not intended to replace or be a substitute for attendance at, and participation in, scheduled class activities. It is designed to complement these activities. Web-CT is typically used to make available information distributed or used in class (such as PowerPoint lecture slides), to provide discussion forums, to provide updated material and/or to provide self-assessment opportunities, for example, through interactive multiple choice questions or through the provision of answers to assigned self-study questions.

Despite the intention that the use of on-line delivery platforms would complement traditional classroom-based delivery, casual observation and anecdotal evidence suggests that a significant number of students see the two as substitutes for one another. As more extensive use is made of the Web-CT platform, attendance rates at some classes are tending to drop. Coinciding with this observation, at least in Australia, evidence suggests that university students are spending less time on campus, and are committing themselves to working longer hours per week to finance their educations, than in previous years (McInnis et al. 2000). Evidence from the UK and Ireland also indicates that university attendance rates are negatively associated with the amount of hours worked in part-time employment (Rolfe, 2002; Kirby and McElroy, 2003).

A tendency for students to spend less time on campus creates concern about the impact that lower class attendance rates may have on student learning outcomes and ultimate student performance. It also stimulates curiosity about whether the provision of self-assessment opportunities on-line mitigates any potential negative impact of lower attendance rates. The aim in this paper is not to evaluate the quality or effectiveness of face-to-face teaching relative to other modes, but to assess the impact of the choices that students are making in relation to class attendance and the use of on-line learning resources.

Specifically, the purpose is to investigate the impact of both attendance rates and the use of on-line self-assessment questions on student performance in a second year management accounting course. By controlling for a variety of factors that affect performance, the aim is to determine whether, as expected, students taking this management accounting course benefit by attending classes and by using on-line self-assessment tests. The on-line tests provide a formative assessment opportunity for the students. That is, the results are used purely to provide feedback to the students and not to contribute to a formal evaluation of performance. An associated aim of the study is to determine whether students taking this course are able to compensate for non-attendance at class by using the on-line self-assessment tests.

The remainder of the paper is organised as follows. Evidence from prior research is presented first. This is followed by presentation of the research hypotheses and a description of the current study. The results are then presented and discussed.

EVIDENCE FROM PRIOR RESEARCH

Formative assessment

Yorke (2001) states that formative assessment is critical for student learning. Formative assessment provides feedback to students, and is not used as an evaluation tool (Buchanan, 2000). It draws attention to areas requiring further study and therefore should lead to improvements in performance (McAlpine, 2002). In contrast, summative assessment is conducted to appraise a student's overall performance (McAlpine, 2002). Although it is often administered at the end of a course by examination, it can include continuous assessment tasks such as mid-term tests and assignments (Morris et al., 2004).

The findings into whether formative assessment does improve performance are mixed. A positive relationship between formative assessment and subsequent performance on summative assessment tasks has been identified (Zakorzewski and Bull, 1999; Sly, 1999; Sly and Rennie, 2000). Sly and Rennie (2000), for example, found that students who sat an optional practice test performed significantly better on their summative assessment than those students who had not sat the test. In contrast, Peat and Franklin (2003) failed to find a significant relationship between formative assessment and summative assessment learning outcomes.

In an earlier study, Schmidt (1983) examined how attempting formative multiple-choice questions impacted on the performance of students on questions of the same type on a final examination. Only some students had access to optional weekly multiple-choice question sets that did not contribute to the overall course grade. Schmidt found that the students who had access to the formative assessment questions performed significantly better on the examination questions than did students who could not access the weekly question sets.

In the present study, formative assessment took the form of a series of computer-based multiple-choice quizzes. Pedagogically, there are limitations to the usefulness of multiple-choice questions. However, they are easily converted and administered on a computerised basis (Buchanan, 1998). Computer-based formative assessment of this type is an efficient and effective means of providing feedback to students, and the assessment task can be taken repeatedly and on a flexible basis, that is, at a time and place chosen by students (Buchanan, 1998; Buchanan, 2000; Peat and Franklin, 2003). Assessment of this type is perceived by students to be useful for learning (Buchanan, 1998; Peat, 2000; Peat and Franklin, 2002).

Attendance

St. Clair (1999) notes a paucity of empirical research investigating the relationship between attendance at classes and student performance, and the results of the research that has been conducted are mixed (St Clair, 1999; Moore, 2003). For example, Buckles and McMahon (1971) found that there was no relationship between student understanding of economics and their attendance at lectures. Similar results were obtained by Browne et al. (1991) in their investigation of the relationship between lecture attendance and student learning outcomes. Others such as Romer (1993), Durden and Ellis (1995), Devadoss and Foltz (1996), Rodgers (2001), Marburger (2001), and Moore (2003) report a negative association between absenteeism and student performance.

Unfortunately, the studies that do find a positive relationship between academic outcomes and attendance exhibit a number of methodological differences, and suffer from a variety of potential weaknesses, that bring the interpretation of their results into question and inhibit comparability across studies. One potentially important difference is in the type of attendance being measured and how it is measured. Devadoss and Foltz (1996) found that attendance at participation-oriented lectures had a greater impact on achievement than did attendance at traditional lectures in which students are passive listeners. Schmidt (1983) found that the total time spent attending a course was not significantly related to student learning, but that particular class types were. Specifically, he found that time spent in lectures was the most productive followed by time engaged in private study, while time spent in discussion was the least productive. Thus it appears necessary to be specific about the type of class being investigated.

The method of measuring attendance rates has also varied across studies. Attendance data has been obtained from student self-reports (Durdin and Ellis, 1995), instructor records (Rodgers, 2001), and sampling attendance at a few classes (Romer, 1993). Furthermore, most studies do not report on the implications of non-attendance for students. It is useful to know whether there are minimum attendance requirements in place, whether marks are available for good attendance, or lost for absenteeism, and whether any other special incentives are given to encourage attendance.

Studies have differed on the variable measured to capture student performance. Some studies have used results on a specific test (Browne et al., 1991; Rogers, 2001), or on a set of tests conducted throughout the semester (Marburger, 2001). Others have used the overall grade achieved, usually on a four or five point scale (Devadoss and Foltz, 1996; Moore, 2003). Some have used the percentage grade achieved on a range of assessment tasks such as mid-term tests, tutorial tests and final examinations (Rodgers, 2001).

A final and potentially serious cause of the inconsistent results reported in prior studies of the relationship between attendance and performance is the extent to which each controls for the effects of extraneous variables. Some studies make no explicit attempt to control for confounding variables (Marburger, 2001; Moore, 2003). Some employ very simplistic control procedures (Romer, 1993), while others estimate multivariate models with a large number of control variables (Devadoss and Foltz, 1996; Rodgers, 2001). After controlling for variables that might also influence performance, such as personal characteristics, course level, and instructor-specific characteristics, both Devadoss and Foltz (1996) and Rodgers (2001) report a significant relationship between class attendance and student performance. As outlined below, there is a multitude of factors potentially contributing to student performance. If appropriate controls have not been employed, it is difficult to be confident in attributing impacts on performance to attendance patterns.

THE RESEARCH HYPOTHESES

Consistent with the work of Sly (1999), Zakarzewski and Bull (1998), Buchanan (2000) and Sly & Rennie (2000), it is expected that there will be a positive relationship between the use of formative assessment by students and their performance on summative assessment tasks. The source of the impact is two-fold. First, if formative assessment is accessible by students at any time throughout a course, as it was in the present study, it can be used to acquire or consolidate specific knowledge relevant to a continuous assessment task. Secondly, if it is available at the end of the course prior to the final examination, as it was in the present study, it can be used as a revision tool, potentially leading to enhanced performance on that examination. Since the use of formative assessment should affect both continuous assessment and examination results, overall student performance should be enhanced by its use. Thus the following hypothesis is proposed:

H1: There will be a positive relationship between student use of formative assessment tasks and their overall performance in a particular course.

As noted above, after employing control procedures, Devadoss and Foltz (1996) and Rodgers (2001) found a positive association between attendance at classes and student performance. In the context of this study, student attendance at class was essentially voluntary because there was no specific penalty for absenteeism or any specific reward for attendance. Consistent with Devadoss and Foltz, it is expected that attendance at tutorials, in which students actively participate, is likely to have the greatest impact on performance. Thus it is anticipated that there will be a positive correlation between the decision to attend tutorial classes and student performance. The hypothesis to be tested, therefore, is:

H2: There will be a positive relationship between student attendance at tutorial classes and their overall performance in a particular course.

The two separate impacts hypothesised above are only likely if the material covered in tutorial classes and available on-line do not directly duplicate each other. While each mode may cover similar, broad topic matter, in contexts where both face-to-face and online mechanisms are designed as integral components of a course, it is anticipated that each mode will add value to student learning in different ways. This is because each is being used in a complementary way to emphasise different aspects of course content. It is not the modes *per se* that are expected to make a difference; rather, it is the differential nature of the material available from each that is expected to contribute to improved performance.

A further exploratory question is pursued in this study in relation to the value added to learning when both on-line and face-to-face modes are used as complementary components in a course. Students might benefit from a synergistic effect that is generated from both attending classes and making use of the formative self assessment opportunities provided. This would be an interaction effect that occurs if these two modes interact to provide a gain in excess of the sum of the individual impacts of each alone. Alternatively, despite the intention of the course designer that students need to engage in both modes to maximise learning outcomes, it may be that if a student either attends classes or makes use of the self-assessment questions, performance will be enhanced, but doing both provides no further performance reward. This would be a substitution effect in that

the skills obtained from engaging in one mode are sufficient to prepare the student for assessment, and no further performance enhancement is obtained from engaging in the other.

Presumably, if a course is designed in anticipation of students availing themselves of both face-to-face and on-line learning opportunities, as was the case with the course examined in this study, these two modes would not simply provide duplicated material. The expectation would be that the performance enhancement follows from a complementary and differential effect that class attendance and the use of self-assessment opportunities have on each other, suggesting a synergistic relationship rather than one of substitution. If a synergistic interaction effect exists, then the performance of students who both attend tutorials and take advantage of self-assessment opportunities ought to be superior to students who participate in only one of these activities. Thus a further hypothesis is tested:

- H3:** There will be a positive interaction effect between student use of formative assessment tasks and student attendance at tutorial classes and their overall performance in a particular course.

DESCRIPTION OF THE STUDY

The research setting

The study was conducted using data from a second year, one semester, management accounting course conducted on the Hobart campus of the University of Tasmania. The course is a compulsory one within the accounting major. To be eligible to take this course, students must have successfully completed first year foundation units in accounting and in quantitative methods.

The course ran over thirteen weeks. Each week one ninety-minute lecture was scheduled and students were also allocated to a tutorial group which met weekly for ninety minutes. In the year of the study, there were five tutorial groups made up of 18 to 20 students each. The same tutor conducted all tutorials in the course on the Hobart campus. Detailed solutions to tutorial questions were not made available to students outside the tutorial sessions. Students attending tutorials regularly had the opportunity to clarify concepts, listen to the questions and explanations of others, practice problem solving skills and obtain feedback on problems attempted on all of the topics covered in the course. The opportunity to obtain this sort of feedback and guidance was not available via other avenues. Tutorial attendance, if it is effective, should influence student performance throughout the semester as reflected in continuous assessment task performance as well as preparing students generally for the final examination.

Although it was stated in the course outline that students were expected to attend lecture and tutorial classes, there was no specific reward for attendance or any specific penalty for non-attendance. At the first lecture, all students were issued a course outline that explained the role of lectures and tutorials. It also specified self-study expectations for students, including information about self-test question sets accessible on the course's Web-CT site. For each weekly topic, a set of ten multiple-choice questions was available, providing immediate feedback that students could use to gauge their progress and understanding.

A total of eleven separate formative self-assessment question sets was available to students and these were only available on Web-CT. There was no compulsory requirement that these questions be attempted, there were no assessment marks associated with them, and students could attempt the question sets as often as they liked and whenever they liked throughout the semester. All sets were available at the start of the semester and remained available until after the date of the

final examination. The formative assessment provided to students in the current study allowed them to assess the soundness of their technical calculation skills. It also reinforced their understanding of basic concepts that would be needed when problem solving on assignments and on the final examination. Further, some multiple choice questions were included on the final examination. Thus use of these self-tests should have prepared students for this type of question when encountered in summative assessment.

In addition to making these questions available, Web-CT was used to provide copies of the PowerPoint slides used in lectures, to make administrative announcements and to run a voluntary discussion forum. This forum was used rarely by the students except to clarify administrative issues. Web-CT had been used in courses previously studied by this cohort of students, so all should have been familiar with its features.

Summative assessment in the course comprised three assignments each worth 10 percent of the total assessment (submitted in weeks 5, 10 and 12 of semester), and a final examination worth 70 percent of the total assessment. The examination included multiple-choice questions (worth 25 percent), with the remainder of the paper divided approximately equally between computational questions and discursive/interpretive questions.

Controlling for other factors affecting student performance

Apart from the impact of formative assessment and attendance at classes, there is an extensive range of other factors that potentially influence student performance. These include general academic ability, age, gender, the entry path taken to university, whether a student is repeating the course, and whether a student's status is full-time or part-time.

Many studies have established a strong relationship between general ability and performance in accounting courses (Dockweiler and Wills, 1984; Hicks and Richardson, 1984; Clark and Sweeney, 1985; Ingram and Petersen, 1987; Booker, 1991; Doran et al., 1991; Ward et al., 1993; Gist et al., 1996; Turner et al., 1997; Wooten, 1998; Koh and Koh, 1999; Davidson, 2002). An exception is the study of Bartlett et al. (1993) who found no significant effect on performance for this factor. A variety of measures of general ability has been used including the results of an aptitude test (Booker, 1991; Ward et al., 1993; Wooten 1998), grade point averages (Dockweiler and Wills, 1984; Clark and Sweeney, 1985; Ingram and Petersen, 1987; Turner et al., 1997; Davidson, 2002), university entrance scores (Farley and Ramsay, 1988; Auyeung and Sands, 1994) or a combination of these measures (Eskew and Faley, 1988; Gist et al., 1996).

The results of accounting related studies into the impact of age and gender on performance are inconclusive. Koh and Koh (1999), for example, determined that younger students performed better, while Naser and Peel (1998) identified no impact of age on performance. De Lange et al. (1997) and Koh and Koh (1999) found males perform better, while Tyson (1989) found that females perform better. Studies by Tho (1994), Gist et al. (1996), Jackling and Anderson (1998), and Naser and Peel (1998) indicate that gender does not contribute significantly to performance variability. A number of studies suggest that gender ceases to be a significant predictor of performance after controlling for the general ability of students (Keef, 1989; Ramsay and Baines, 1994; Keef and Roush, 1997).

Jackling and Anderson (1998) found that part-time students performed better, and speculated that this was due to part-time students being older and more mature in their approach to study, having often gained work experience in the accounting area, and being more highly motivated than other students. In an Australian study focused on non-accounting students, McKenzie and

Schweitzer (2001) determined that there was no difference between the performance of full-time and part-time students, but that full-time employees studying part-time, and full-time students with no employment, performed better than full-time students with part-time work commitments.

The question of whether or not repeating an accounting course is a predictor of performance has been examined. Baldwin et al. (1989) found that this factor did not predict a better grade, while De Lange et al. (1997) found that students repeating a first year open learning course performed worse than non-repeating students.

Although the research results are mixed, there is clearly several variables that may affect student performance outcomes. If controls have not been employed to account for the effects of these variables, it is difficult to be confident in attributing impacts on performance to attendance patterns and/or the use of formative assessment opportunities. Thus a number of control variables are included in the models estimated in this study in order to capture these potentially confounding effects.

The sample

The sample was made up of students who were enrolled in the management accounting course on the Hobart campus and who completed the final examination. This gave a potential sample size of 94 students. However, this was reduced to 68 after eliminating students for whom data was not available on all of the variables required. Specifically, the tertiary entrance score was selected as the best proxy for general ability. However, this was not available for students taking a non-traditional path into university, such as mature age students, those entering with a diploma rather than the traditional tertiary entrance preparations, and overseas students. Alternatives such as a grade point average on other units studied prior to undertaking the unit of interest had similar limitations in that students transferring to university with a local or overseas diploma, a relatively common occurrence in Australia, often took the unit being analysed in their first year of study.

Thus 26 students were eliminated from the final sample. Testing revealed that these students were not significantly different from the remaining group in terms of performance outcome or tutorial attendance rates. However they were significantly more likely to utilise the on-line self-assessment opportunities¹. Of the remaining 68 students, 44 percent were male and 56 percent were female. Twenty-one percent were repeating students. Almost 80 percent of the sample was studying full-time. Age ranged from 20 to 31 years, with the average age being 22.5 years. As noted, the sample did not include students from non-standard entry categories such as from overseas institutions, special entry students (such as mature age entrants), or transfers from technical or vocational studies.

The variables

(a) Dependent variables

The dependent variable for the hypotheses is overall student performance in the one-semester management accounting course. This was calculated as the total combined marks, scaled out of 100, achieved by a student on final examination and the marks awarded to the student for the three

¹Given this result, the models were estimated using a noisier measure of general ability – the grade point average on all courses studied by the students at the date at which the data were collected to see if the result on formative assessment use differed when all students were examined. It remained positive and significant, suggesting that the result is robust.

assignments submitted during the semester. The performance data were collected from audited records maintained in the School of Accounting and Finance. Assessment marks were not standardised.

(b) Explanatory variables

The first hypothesis predicted that the use of formative assessment would help to explain summative assessment results. The formative assessment of interest in this study comprises weekly multiple-choice question sets available to students on Web-CT. Web-CT keeps statistics on which question sets each student attempts and how many attempts each has made per set. The statistics kept did not indicate how many questions a student answered in each attempt on a set. Hence the variable capturing formative assessment usage cannot be measured in terms of the total number of questions attempted by a student across all sets. Rather, it is measured in terms of the number of attempts that a student made on each question set, regardless of whether only some of the questions in particular sets were answered.

It follows that the formative assessment variable could have been operationalised as either the number of weekly question sets attempted by a student *at least once* or the number of attempts made by a student *in aggregate* across all the weekly sets. It was decided that measuring the number of attempts that a student made in aggregate captured more effectively the extent to which he or she made use of self-assessment opportunities. For example, a student who attempted each of the eleven sets once would have a formative assessment usage score of 11 (11 sets x 1 attempt). A student who made two attempts at four sets but attempted no more would have a score of 8 (4 sets x 2 attempts). Multiple attempts at particular question sets suggest that a student is using the sets constructively to reinforce knowledge in areas where they are less certain and thus it was felt that additional attempts on any set should be specifically captured in the measure of formative assessment use.

The second hypothesis predicted that tutorial attendance rates would help to explain the performance achieved by a student. Attendance records were kept by the tutor at each tutorial class and provide complete and unbiased attendance data. The attendance variable is operationalised as the percentage of the weekly tutorial classes that each student attended.

(c) Control variables

As discussed above, there are many variables that potentially explain student performance. Consistent with prior literature, the general ability of students is likely to be one important factor. The tertiary entrance score for each student was used as a proxy for general ability. Students without a tertiary entrance score were dropped from the data set, which in turn meant that there was no need to control for entry path to university because students from non-traditional entry categories were eliminated in this process. Dummy variables have been included in this study to distinguish first-attempt and repeating students, part- and full-time students, and male and female students. The age of each student is included as a control for any differential effects that age might have on performance.

Data for all of the independent and control variables were obtained from the University's student records system.

The models and testing

The first two hypotheses relating to the direct effects of attendance and the use of on-line self-assessment opportunities were tested using multiple regression analysis to estimate the following multivariate model:

$$\text{PERF} = \beta_0 + \beta_1 \text{FORM} + \beta_2 \text{ATT} + \beta_3 \text{TE} + \beta_4 \text{AGE} + \beta_5 \text{MODE} + \beta_6 \text{GEN} + \beta_7 \text{REP}$$

Where:

PERF = student performance, measured by the aggregate of their continuous assessment and examination score (that is, the total mark the student received in the course)

FORM = use made of formative assessment opportunities by each student, measured by the aggregate number of multiple choice question sets attempted, including repeat attempts on the same set

ATT = class attendance rate, measured as the percentage of weekly tutorial classes attended by each student

TE = general ability, proxied by a student's tertiary entrance score

AGE = student's age

MODE = mode of study, where 0 = full-time and 1 = part-time

GEN = gender, where 0 = male and 1 = female

REP = repeating student, where 0 = non-repeater and 1 = repeat student.

Hypothesis One is supported if the β_1 coefficient in the model is positive and significant. This would indicate that, after controlling for other factors likely to influence performance, the use of formative assessment has a positive incremental impact on student performance. Hypothesis Two is supported if the β_2 coefficient in the model is positive and significant. This would indicate that, after controlling for other factors likely to influence performance, the tutorial attendance rates have a positive incremental impact on student performance.

Hypothesis Three predicted a synergistic interaction between attendance and formative self-assessment and their resultant impact on performance. To assess whether the formative assessment and attendance rates generate an interaction effect on overall performance, a regression is run which includes the interaction term FORM*ATT. The model estimated is:

$$\text{PERF} = \beta_0 + \beta_1 \text{FORM} + \beta_2 \text{ATT} + \beta_3 \text{TE} + \beta_4 \text{AGE} + \beta_5 \text{MODE} + \beta_6 \text{GEN} + \beta_7 \text{REP} + \beta_8 \text{FORM*ATT}$$

If a synergistic interaction effect is present, the coefficient β_8 should be positive and significant. If this is not the case, the effect may be one of substitution and further investigation

would be needed to determine whether that effect is present. To obtain some insights, the sample would need to be subdivided into four groups as follows:

- Group 1: students who make relatively high use of formative assessment and have high tutorial attendance rates (high users of on-line assessments and good attendees)
- Group 2: students who make relatively high use of formative assessment and have low tutorial attendance rates (high users of on-line assessments and poor attendees)
- Group 3: students who make relatively low use of formative assessment and have good tutorial attendance rates (low users of on-line assessments and good attendees)
- Group 4: students who make relatively low use of formative assessment and have poor tutorial attendance rates (low users of on-line assessments and poor attendees)

If attendance and formative assessment substitute for each other in terms of their impact on performance, there should be no difference between the average scores of Group 1, 2 or 3, after controlling for the effects of other factors potentially influencing performance. That is, students making frequent use of the self-assessment tasks and having higher attendance rates should do no better, on average, than students choosing to take advantage of either but not both of these opportunities. Similarly there should be no difference in the performance of those students with frequent formative assessment use and poor attendance rates and those with good attendance records but who make infrequent use of the formative assessment opportunities. However, the performance of these groups should be significantly higher than that of group four.

To assess whether a substitution effect is apparent, analysis of covariance (ANCOVA) can be used to estimate a general linear model which includes, in addition to the explanatory and control variables described earlier, a categorical contrast variable taking on the values of one to four representing the groups delineated above. If this variable is significant in the model, this indicates that group membership does affect average performance. Further, ANCOVA provides mean performance scores for each of the groups, adjusted for the effects of the control variables, to facilitate comparison of group means should differences emerge.

RESULTS

Descriptive statistics for the explanatory variables are provided in Table 1. On average, students attempted between four and five of the questions sets. Some attempted no sets, while the maximum was 33 separate attempts at the sets, reflecting the fact that some students did make multiple attempts at the same question set. Attendance rates varied from zero to 100 percent, with the average attendance rate being just over 60 percent.

The model testing Hypotheses One and Two was estimated using multiple regression analysis. The correlation coefficient matrix for the continuous variables is provided in Table 2, and parameter estimates for the model and their significance are presented in Table 3.

TABLE 1**Descriptive statistics for formative assessment use (FORM) and attendance rates (ATT)**

	FORM (Number of sets attempted, <u>including multiple attempts</u>)	ATT <u>(%)</u>
Minimum	0	0
Maximum	33	100
Mean	4.68	61.1
Standard deviation	0.5	28.4

TABLE 2**Pearson Correlation coefficient matrix**

	<u>PERF</u>	<u>FORM</u>	<u>ATT</u>	<u>AGE</u>
FORM	.281*			
ATT	.231*	.065		
AGE	-.019	.329*	-.104	
TE	.457*	-.066	.095	-.528*

* Correlation is significant at the 0.05 level

TABLE 3**Coefficients and significance for the relationship between formative assessment use (FORM), attendance rates (ATT) and summative assessment outcomes (PERF)**

	<u>b</u>	<u>Significance</u>
Intercept	-20.910	0.165
Explanatory variable		
FORM	0.506	0.026
ATT	0.095	0.045
Control variables		
TE	0.392	0.000
AGE	1.979	0.008
MODE	0.465	0.369
GEN	-4.682	0.073
REP	-6.716	0.054

Adjusted R-Squared 34.8% (F = 6.099, p = 0.000)

The results provide support for both hypotheses. As predicted in Hypothesis One, the coefficient on the formative assessment variable is both positive and significant, suggesting that the greater the use students make of the formative assessment questions, the higher their final aggregate mark in the course is likely to be². Hypothesis Two suggested a positive relationship between tutorial attendance rates and overall assessment outcomes for students. Again, the results support the hypothesis. The relationship between attendance rates and total assessment outcomes is positive and significant, after controlling for other factors likely to influence performance.

For Hypothesis Three, the regression model was re-estimated with the interaction term β_8 FORM*ATT included to assess whether a synergistic interaction effect was evident. This term was not significant ($t = -1.201$, $p = 0.24$, results not tabulated). The sample was then divided into the four sub-groups described in the previous section. To distinguish high and low use of formative assessment and good and poor attendees clearly, the sample was split on the median³ for each of attendance rate and quiz attempts. Students who were above the median were considered to be high attendees and high users of formative assessment, respectively, while those below the median were considered to be poor attendees and low formative assessment users. Students sharing the median attendance rate or number of quiz attempts were eliminated from the sample for this part of the analysis. This reduced the sample size to 54. Descriptive data for each group are provided in Table 4.

TABLE 4

Raw Means for PERF, FORM, and AT for the Three Groups

	PERF (Total marks)	FORM (No. of attempts)	ATT (%)
Group 1 (n = 12) High usage, good attendance	59.62	10.3	83.3
Group 2 (n = 10) High usage, poor attendance	51.59	10.5	38.2
Group 3 (n = 16) Low usage, good attendance	57.73	1.3	86.9
Group 4 (n = 16) Low usage, poor attendance	45.06	0.5	31.2

²The model was also estimated using the number of quizzes attempted rather than the total number of attempts made on all quizzes. The result remained significant and positive, suggesting that it is not sensitive to the particular way in which use is measured.

³The data were examined to see if there appeared to be a natural splitting point other than the median. None was clearly apparent, although a break in the data for number of attempts did occur and the analysis was redone using this as the splitting point. This did not significantly alter the results.

To assess the existence of a substitution effect, a general linear model was estimated using ANCOVA. This model included all of the variables in the regression model used to test Hypotheses One and Two, plus a categorical contrast variable to distinguish the groups. This variable, *M*, took one of the following four values:

- M* = 1: high attendance rates and high formative assessment use
- M* = 2: low attendance rates and high formative assessment use
- M* = 3: high attendance rates and low formative assessment use
- M* = 4: low attendance rates and low formative assessment use

The covariate-adjusted mean performance scores for each of the groups are reported in Table 5, but results, not tabulated, indicate that group membership did not produce a significant main effect. Although there was no significant difference in the performance of groups one, two and three, the performance of these groups was also not significantly different from that of group four, suggesting no interaction effect at all.

This is confirmed by the graphical analysis⁴ presented in Figure 1. The relationship between covariate-adjusted mean performance and formative assessment use is plotted for the high and low attendance groups respectively. Both lines slope upwards, consistent with the main effects noted, but they are effectively parallel, suggesting no interaction effects. If a substitution effect existed, the two lines should converge or cross over the relevant range whilst a synergistic effect would see them diverge. None of these effects is apparent.

Overall, then, the results suggest that both class attendance and the use of formative self-assessment opportunities produce significant independent improvement in student performance. However, there is no further synergistic performance improvement to be achieved from both being a good attendee and a high user of the self-assessment quizzes. Further, attendance and self-

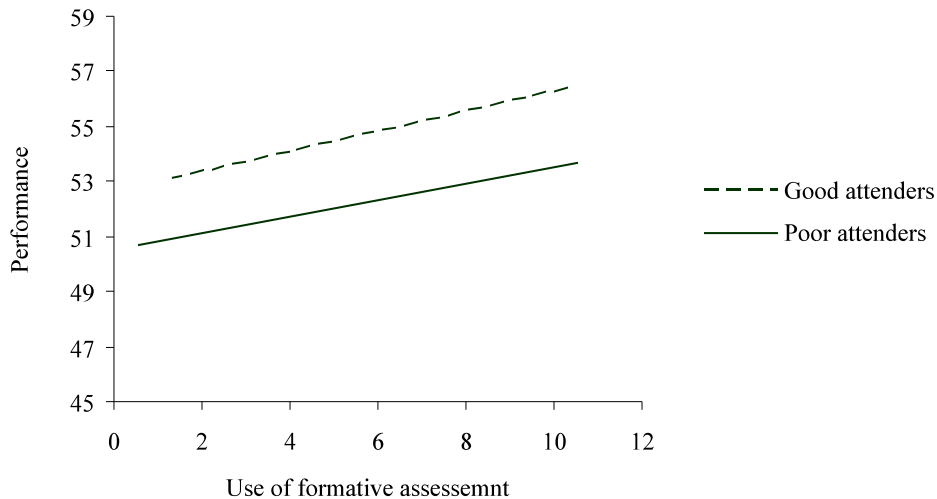
TABLE 5

Covariate-adjusted means for PERF

	<u>PERF</u>
Group 1 (n = 12) High usage, good attendance	56.46
Group 2 (n = 10) High usage, poor attendance	53.67
Group 3 (n = 16) Low usage, good attendance	53.16
Group 4 (n = 16) Low usage, poor attendance	50.69

⁴We are indebted to an anonymous reviewer for suggesting this part of the analysis.

FIGURE 1

Graphical analysis of potential interaction effects

assessment opportunities do not act as substitutes for each other. That is, students cannot compensate for poor attendance by making greater use of the self-assessment opportunities and vice versa.

DISCUSSION, CONCLUSION AND LIMITATIONS

Universities today are increasingly aiming to incorporate greater flexibility into their courses. A more flexible approach, in this context, is understood to be one that increases the degree of students' control over their learning, which in turn implies learning that is less time and place dependent than that associated with the typical delivery of courses in the past. A more flexible approach is often coupled with the use of on-line delivery platforms. At one end of the spectrum, this may involve delivery of courses exclusively on-line with no scheduled face-to-face classes, but these platforms are also now widely used as an adjunct, playing a supporting role in courses designed with a central face-to-face teaching component.

Well-designed courses, delivered exclusively on-line, are able to provide students with rewarding learning experiences, and are not the source of concern here. Such courses play an important role in providing access to tertiary education to those for whom physical attendance at university is difficult, for example, the geographically remote. Rather, the concern here is with courses that are designed with a central face-to-face teaching component, coupled with some degree of on-line support, in which the learning strategy has been developed with the expectation that students will participate in both the classes and the on-line activities. Despite these two components being seen as complementary learning tools by course designers, with students expected to take advantage of both modes, many students are electing not to attend some or all of their classes.

In this context, the results of the present study are pertinent. First, that on-line formative self-assessment opportunities can enhance student performance on summative assessment tasks confirms the efficacy of such learning tools in supporting wider course objectives. It would be surprising if this were not the case. Self-assessment tools of this type, if they are properly designed, repeatable,

and provide immediate feedback, serve to clarify difficult conceptual issues raised in class, and alert students to the matters that the lecturer believes are most significant.

Further, the results do not support the notion that in this course at least, students can compensate for poor attendance by using the supporting on-line activities. This result has important implications for educators and policy makers. As long as it is accepted that there is a legitimate place in tertiary education for courses designed with a central face-to-face component, the problem of students absenting themselves from classes, and the associated diminished learning outcomes that flow from this, may not be solved by simply providing increasing levels of on-line technological support. Such support can enhance the learning experiences of students who regularly attend class but does not offer a satisfactory alternative to attendance.

Instead, steps may need to be taken to ensure that non-attendance at class is minimised. One way to do this is to provide extra motivation to students to attend class. Assessment in a course may be made dependent to some extent on attendance, for example, by planning for regular assessable activities to be undertaken in class. Alternatively, offering students who have other conflicting commitments more flexible timetable arrangements would make it easier for them to attend class. An extended block of scheduled class time, perhaps outside normal hours or even at weekends, requiring a reduced number of visits to campus, is one example of how this might be achieved.

The teaching strategies that are being used in particular courses need to be explained very carefully to students, and they need to know how each specific strategy is intended to support the desired learning outcomes, both generic and specific, in those courses. If students understand the role that both technological support and class attendance are meant to play in their courses, they can make more informed decisions about the choices they make. Similarly, course designers need to be aware of the various ways in which learning outcomes can be promoted and to understand when students can reasonably substitute the opportunities available without compromising performance and, importantly, when they cannot. Where a portfolio of learning modes is available to students, course designers need to map each carefully to specific and generic graduate outcomes and articulate this mapping to facilitate rational student choices.

As is always the case, the results of this study together with the implications identified above need to be evaluated in the context of the limitations inherent in the particular research approach taken. The possibility of spurious correlations and omitted variables has to be acknowledged with any study of this type. Whilst the results suggest a relationship between attendance and performance and the use of formative assessment and performance, no causality can be imputed. It could be, as noted, that these measures are proxying for the effect of some other unspecified variables.

Further, although an attempt was made to control for a variety of factors that affect performance, there are, as Bartlett et al. (1993) note, potentially many other student characteristics that also affect performance which have not been incorporated into this study. Motivation, learning style, personal values and attitudes, and maturity are just some of the characteristics which fall into this category. Characteristics of this type might moderate, mitigate or enhance the effect of the variables observed in this study. However, the constructs needed to capture these characteristics are complex and very difficult to operationalise in a study of this type. Complementary qualitative research studies may be required to provide useful insights into the nature and effect of such factors.

Finally, this study uses data from an Australian second year management accounting course and considers only one type of formative assessment, multiple choice question sets. As such, the generalisability of the results to other jurisdictions, other subject areas and other forms of formative assessment may be limited. Nonetheless, the increasing use of on-line learning resources in tertiary

education, and their ability to provide efficient interactive formative assessment opportunities, is undeniable. Replication of research of the type presented here across different settings may provide further useful and robust insights into the potential impacts that this development is having on student performance outcomes.

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