

Computer managed learning: a new approach with an old tool

Leith Sly
Centre for Educational Advancement
Roger Stace
Curtin Business School
Curtin University of Technology

The mainframe based computer managed learning (CML) system in use at Curtin University of Technology generates approximately 30,000 student tests each year. Although the CML system is an old tool used mainly for summative testing it has features that enable its use for formative assessment. This paper reports the results of an Accounting study investigating student performance on CML assessed tests as well as possible factors affecting either performance or choice to sit the practice test. Student ability, anxiety and attitude to CML were investigated. The data do not suggest that the more able students sat the practice test. Neither does it suggest that either attitude to CML or anxiety affect student choice to sit a practice test. Student anxiety levels did not affect CML test performance. The 78 (41.1%) students who chose to sit the optional practice test performed better on the assessed test than those who did not (72.9% vs 65.6%, $p=0.003$). Students liked the CML system and felt it accurately assessed their understanding of the unit. The results of the present study suggest that CML is an effective formative assessment tool and that students should be strongly encouraged to sit a practice test before each assessed test.

Introduction

Computer managed learning (CML) systems are software packages with several common features, including generating tests from banks of questions, marking the tests generated, analysing the results and keeping records of students' marks and progress. Most systems are able to generate tests that use multiple-choice, true-false, short answer, matching, calculation and assignment questions. They usually have the ability to mark all except the assignment questions, although the short answer questions are often quite restrictive. CML systems have been used for many years predominantly for summative assessment.

The computer managed learning system in use at Curtin University of Technology is a mainframe-based computer testing system run through a central testing laboratory. Each year approximately 30,000 student tests are generated and marked by the system. Questions are held in testbanks and students draw randomly generated tests according to parameters set by the lecturers but held within the CML system. Most lecturers use the CML system for part of their summative assessment with tests typically contributing about 20% to the final unit mark. However, not all lecturers allow students to sit a practice test and if they do this is only before the first assessed test.

Several studies (Sly, 1999a; Sly, 1999b; Sly & Rennie, 1999; Sly & Western, 1998) have previously shown that students who do a practice test tend to increase their performance on the subsequent assessed test. The increase in performance is not restricted to any particular subject discipline and the range of the increase in group mean mark is 5 to 30 percent with effect sizes from .34 to 2.0 (Sly & Rennie, 1999). When given the choice to take an optional practice test, an average of 55% of students choose to do so, however this ranges across subject disciplines from between 40% and 69%.

The present study was undertaken both to demonstrate that those students who perform a practice test score higher marks on the subsequent assessed test and to determine possible factors affecting both student choice to sit a practice test and student performance on the subsequent assessed test.

Methods

Students enrolled in a first year Accounting unit of one semester duration participated in this study. They were able to sit a CML practice test prior to their CML assessed test. The CML component of the unit assessment consisted of an optional ten-question practice test and three compulsory twenty-question assessed tests. All questions were multiple choice. Only the first assessed test is considered in this study as it was the only test preceded by a practice test. It covered material from the four topics: Business and Accounting, Introduction to Financial Statements, Measurement of Profit, and Owners and Creditors as Users of Accounting Information. The content covered by the practice test was 75% of the content covered by the assessed test. Differences in scores between groups were tested for statistical significance using t tests. The magnitude of the difference was examined using effect sizes where effect size is the difference between means divided by the pooled standard deviation (Hedges, 1981). Effect sizes for the correlated comparisons are calculated following Dunlap, Cortina, Vaslow and Burke (1996).

Student ability, student attitudes to CML, and student anxiety were investigated in order to determine possible reasons for students' choice to sit a practice test. Anxiety was also investigated in relation to CML test performance as scores on anxiety measures usually show negative correlations with performance on achievement tests (Anderson & Sauser, 1995; Culler & Holahan, 1980; Gross & Mastenbrook, 1980; Hembree, 1988; Hunsley, 1985; Mandler & Sarason, 1952; Paulman & Kennelly, 1984; Sarason, Davidson, Lighthall, Waite & Ruebush, 1960; Williams, 1996; Zoller & Ben-Chaim, 1988).

The final examination for the semester was the performance measure used as an indicator of student ability for this group of first year Accounting students. This examination was worth 50% of the total unit mark, covered the entire course and was not run on the CML system.

Student attitudes to CML were investigated by an eight-question survey handed to students at the end of the unit. Questions were asked about the student's attitudes to the CML testing system as well as their use of the practice test. Those students who sat the practice test were asked how they prepared for the test and how they felt it helped their performance on the assessed test. Those who chose not to sit the practice test were asked why they did not. Where appropriate, students responded to a five point Likert scale. They were also given three opportunities to add unstructured responses.

The anxiety component of the study was designed around self-evaluation questionnaires. During a lecture, prior to the practice test being available, students were asked to complete a self-evaluation questionnaire that measured trait anxiety. Prior to the first assessed test students were again asked to complete a self-evaluation questionnaire but this time the questionnaire measured state anxiety.

Spielberger (Spielberger, 1972; Spielberger, 1976) distinguished between the stress of the exam, the threat this poses to an individual and the resulting state anxiety (S-Anxiety) that may be evoked. He saw trait anxiety (T-Anxiety) as second type of

anxiety that was a relatively stable indicator of individual difference in anxiety proneness as well as an estimator of the probability that anxiety will be experienced in stressful situations.

The instrument used was the State-Trait Anxiety Inventory for Adults by Charles D. Spielberger (1983). It comprises separate self-report scales for measuring state and trait anxiety. The State (S)-Anxiety scale has twenty statements that are used to evaluate how the person feels “right now” and the Trait (T)-Anxiety scale has twenty statements that assess how the person feels “generally”.

Results

Part 1: CML test results

Table 1 reports test results for 190 students of whom 78 (41%) chose to sit the optional practice test. The group mean mark for those students who sat the optional practice test increased from 65.64 to 72.88, which is a statistically significant difference (dependent $t=4.06$, $p<.001$) with an effect size of 0.41. This group of students performed better on the first assessed test than the group who had not sat the practice test. The difference was statistically significant (independent $t=3.03$, $p=.003$) with an effect size of 0.45.

Table 1: Mean scores (%) on the CML assessed

| Test | Practice test group | | | Non practice test group | | | t |
|----------|---------------------|-------|-------|-------------------------|-------|-------|--------|
| | N | Mean | SD | N | Mean | SD | |
| Practice | 78 | 65.64 | 19.20 | | | | |
| Assessed | 78 | 72.88 | 15.76 | 112 | 65.58 | 16.76 | 3.03** |
| Part A | 78 | 75.90 | 17.95 | 112 | 68.81 | 16.96 | 2.77** |
| Part B | 78 | 63.59 | 20.32 | 112 | 55.90 | 25.06 | 2.33* |

* $p<.05$, ** $p<.01$

In this study, the optional practice test covered three quarters of the content covered by the assessed test. For the purposes of this analysis, the assessed test was divided into two parts. Part A contained 15 questions and covered topics previously examined by the practice test (topics 1,2 and 3) while Part B contained 5 questions and covered a topic not previously examined (topic 4). Table 1 also reports the percentage mean scores for Parts A and B of the assessed test.

The 78 students who sat the practice test performed better on Part A (topics which were included in the practice test) than on Part B, which was new work. The effect size for the difference between the practice test and Part A is modest at 0.55, but between the practice test and Part B is small and negative, at 0.10. Only the difference between the practice test and part A is statistically significant ($t=5.55$, $p<.001$). However, it can be seen that those students who did not sit the practice test also performed better on Part A than on Part B (68.81 vs 55.90), suggesting that Part B was harder.

Part 2: Results of possible factors affecting student choice to sit a practice test

Student ability, student attitudes to CML and student anxiety were considered as possible factors affecting students' choice to do a practice test.

Student Ability

Based on the final semester examination for this unit there was no difference in the mean mark between those students who elected to sit the practice test and those who did not (63.9% vs 60.0%, $t=1.49$, $p=0.14$).

Student attitude to CML

Seventy five students (39.5%) returned the attitude survey. Seventy three answered the question on previous use of the CML system and 36 (48%) reported using the CML system for previous units. As a group, students rated the computer managed learning system highly as a form of assessment, with 53.3% marking 4 or 5 on the five point scale and only 2.7% responding that they hated the system (response 1). A similar proportion of students felt the CML system was able to accurately measure their understanding of the unit. None of the students said that the CML system was very difficult to use and 76% said it was not difficult (Table 2).

Table 2. Student attitudes to the CML system

| QUESTIONS | Response (%) | | | | |
|--|--------------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 |
| How much do you like CML as a form of assessment | 2.7 | 14.7 | 29.3 | 34.7 | 18.7 |
| How well do you think CML assessment measures your own understanding of this unit? | 2.7 | 17.3 | 33.3 | 34.7 | 12.0 |
| How difficult was CML to use? | 0 | 6.7 | 17.3 | 32.0 | 44.0 |

Data are presented with response 1 being the least favourable and response 5 being the most favourable.

Table 3 reports the results of the 49.3 % (37/75) of survey respondents who sat the practice test. Students reported that they did not study before the practice test, with 59.5% reporting no or little study and only 18.9% claiming to have studied a substantial amount. However, most students reported that sitting the practice test "was helpful ... in preparing for the next CML test", with 62.1% marking response 4 or 5. When asked to report how they thought the test was helpful only 14 (37.8%) wrote comments. Nine of these students reported that the practice test was useful because it gave them an idea of what the assessed test was like.

Table 3: Responses from practice test group

| QUESTIONS | Response (%) | | | | |
|--|--------------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 |
| How much did you study for the practice test? | 32.4 | 27.0 | 21.6 | 8.1 | 10.8 |
| Do you think that the practice test was helpful to you in preparing for the next CML test? | 2.7 | 16.2 | 18.9 | 24.3 | 37.8 |

Data are presented with response 1 being the least favourable and response 5 being the most favourable.

Thirty-eight students (50.5%) who returned the survey had not sat the practice test. Most reported that they did not sit the practice test because they did not have enough time (11/38, 28.2%) or they forgot (12/38, 30.8%). Only one student gave previous use of the CML system as a reason for not sitting the practice test.

Student anxiety

Table 4 reports the results of the 102 students who completed the Trait anxiety scale in a lecture prior to the start of their CML testing and the 169 students who completed the State anxiety scale before attempting their assessed test in the CML Lab. There was no difference between those students who sat the practice test and those who did not based on the measure of either their State or Trait anxiety.

Table 4: Anxiety measures

| Task | Practice test group | | | Non practice test group | | | t |
|-------|---------------------|-------|-------|-------------------------|-------|------|-----|
| | N | Mean | SD | N | Mean | SD | |
| Trait | 58 | 43.02 | 8.76 | 44 | 42.34 | 7.65 | .41 |
| State | 70 | 43.70 | 11.38 | 99 | 43.45 | 9.41 | .15 |

Part 3: Anxiety as a possible factor affecting student performance on the assessed test

In order to test whether anxiety affected later performance on the CML assessed test a bivariate correlation was performed using Pearson's correlation. The group was treated in two parts – those students who sat the optional practice test and those students who did not sit the optional practice test. For the group of students who sat the practice test, the level of the students' Trait anxiety before the practice test had no influence on performance on the practice test ($r = -.079$, $p = .555$) nor was performance on the first assessed test affected by either the level of the students' State anxiety ($r = -.160$, $p = .186$) or Trait anxiety ($r = -.203$, $p = .130$). For the group of students who did not sit the practice test there was a no relationship between State anxiety and performance on the assessed test ($r = -.191$, $p = .058$) or between Trait anxiety and performance on the assessed test ($r = -.077$, $p = .622$).

Discussion

The results of this study confirm our previous findings that students who chose to sit an optional practice test score higher marks on the subsequent assessed test than those who do not. In this study, the practice test covered only 75% of the content tested by the assessed test. Students who sat the practice test did perform significantly better on that part of the assessed that was covered by the practice test.

A number of possible explanations were considered to explain the higher scores of those students who sat the practice test. We examined the possibility that it was the more able students, as measured by their final non-CML examination mark, who chose to sit the practice test. However, comparison of the two groups – practice test and non practice test – does not support this possibility.

The practice test may have served to decrease student anxiety, however, the results from the anxiety surveys found no relationship between anxiety measures and choice to sit the practice test or between anxiety and CML test performance.

Another possible explanation is that the group became familiar with both the computer system and the procedure for sitting CML tests. While this may contribute to improved performance we did not directly investigate this. However, the better performance was on Part A, where the practice test provided students with feedback on the content. Students may be using the external feedback that they receive to generate their own internal feedback. This could allow them to modify their approach to the subject matter. The non practice test group did not have this same opportunity as they had no prior exposure to either the type of questions or the question content. Those students who sat the practice test and returned the survey reported that the practice test alerted them to what was likely to be covered in the assessed test.

Given that the investigated factors do not explain increased performance the most likely explanation for better performance would appear to be feedback. The practice test gave the students feedback on which questions they got wrong, alerting them to potential areas of weakness in their knowledge. Used in this fashion the practice test is essentially a formative assessment tool (Brown & Knight, 1994; Rowntree, 1987). By giving students feedback on incorrect answers they have the opportunity to diagnose areas of weakness and increase the effectiveness of their study. This process needs to be formally investigated.

Although only a small number of students returned the attitude survey and as such the data need to be treated with some caution, students did report that the CML system was easy to use and they did like it as a form of assessment. The main reasons given for not choosing the practice test were lack of time or forgetting. There were no major objections to the practice test and those students who used the facility found it helpful.

Summary

These finding suggest that the CML system when used as a formative assessment tool can enhance student performance on later CML assessed tests. This beneficial effect is seen particularly on the section of the assessed test that reflects content of the practice test. Student ability and anxiety levels appear to contribute little to this effect. These data, together with the general acceptability of the CML testing system suggest that practice tests should be available before all CML assessed tests and students strongly

encouraged to sit them. So, an old tool, used for formative assessment can aid a new approach to assessing student learning.

References

- Anderson, S. B., & Sauser, W. I. (1995). Measurement of test anxiety: An overview. In C. D. Spielberger & P. R. Vagg (Eds.), *Test Anxiety: Theory, Assessment and Treatment*. Washington, DC: Taylor and Francis.
- Brown, S., & Knight, P. (1994). *Assessing Learners in Higher Education*. London: Kogan Page.
- Culler, R. E., & Holahan, C. J. (1980). Test anxiety and academic performance: The effects of study related behaviors. *Journal of Educational Psychology*, 72(1), 16-20.
- Dunlap, W. P., Cortina, J. M., Vaslow, J. B., & Burke, M. J. (1996). Meta-analysis of experiments with matched groups or repeated measures designs. *Psychological Methods*, 1, 170-177.
- Gross, T. F., & Mastenbrook, M. (1980). Examination of the effects of state anxiety on problem-solving efficiency under high and low memory conditions. *Journal of Educational Psychology*, 72(5), 605-609.
- Hedges, L. (1981). Distributed theory for Glass's estimator of effect size and related estimators. *Journal of Educational Statistics*, 6, 107-128.
- Hembree, R. (1988). Correlates, causes, effects, and treatment of test anxiety. *Review of Educational Research*, 58, 47-77.
- Hunsley, J. (1985). Test anxiety, academic performance, and cognitive appraisals. *Journal of Educational Psychology*, 77(6), 678-682.
- Mandler, G., & Sarason, S. B. (1952). A study of anxiety and learning. *Journal of Abnormal and Social Psychology*, 47, 166-173.
- Paulman, R. G., & Kennelly, K. J. (1984). Test anxiety and ineffective test taking: Different names, same construct. *Journal of Educational Psychology*, 76(2), 279-288.
- Rowntree, D. (1987). *Assessing Students: How shall we know them?* London: Kogan page.
- Sarason, S. B., Davidson, K. S., Lighthall, F. F., Waite, R. R., & Ruebush, B. K. (1960). *Anxiety in Elementary School Children*. New York: Wiley.
- Sly, L. (1999a). *Computer testing options and benefits of a practice test*. Paper presented at the Teaching and Learning Forum, University of Western Australia.
- Sly, L. (1999b). Practice tests as formative assessment improve student performance on computer managed learning assessments (in press). *Assessment and Evaluation in Higher Education*.

Sly, L., & Rennie, L. J. (1999). Computer Managed Learning As An Aid To Formative Assessment In Higher Education. In Brown, S., Bull, J., & Race, P (Ed.), *Computer Assisted Assessment of Students*. London: Kogan Page

Sly, L., & Western, D. (1998). *Practice tests improve student performance on computer managed learning*. Paper presented at the Forum on Teaching and Learning, The University of Western Australia, Perth Western Australia.

Spielberger, C. D. (1972). Anxiety as an emotional state. In C. D. Spielberger (Ed.), *Anxiety: Current trends in theory and research*. (Vol. 1,). New York: Academic Press.

Spielberger, C. D. (1976). The nature and measurement of anxiety. In C. D. Spielberger & R. Diaz-Guerrero (Eds.), *Cross-cultural research on anxiety*. . Washington, DC: Hemisphere/Wiley.

Spielberger, C. D. (1983). *State-Trait Anxiety Inventory for Adults (Form Y)*: Mind Garden

Williams, J. E. (1996). Gender related worry and emotionality: Test Anxiety for High-achieving students. *Psychology in the Schools*, 33(2), 159-62.

Zoller, U., & Ben-Chaim, D. (1988). Interaction between examination type, anxiety state, and academic achievement in college science; An action-orientated research. *Journal of research in science teaching*, 26(1), 65-77.