Web–based assessment of writing skills

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Abstract
"Communication in the Sciences", a compulsory first year paper for science and applied science students at Massey University, requires that students pass three mastery tests – 'punctuation', 'paragraphing', and 'English and Science' – over a seven week period. In the second semester of 1999 that amounted to 216 students and 2928 tests. We describe and demonstrate the operation of a custom built web–mounted testing facility that generates and grades unique tests from banks of multiple choice questions stored in databases. We discuss the importance of an online administration interface to such testing sites, and provide examples of how our tutors' time is used more effectively and efficiently with the data provided by our site. Data from student reviews and anecdotal evidence are presented to support our view that student learning is positively influenced by a web-based approach.

Introduction
"Communication in the Sciences", a compulsory paper for all first year science students at Massey University (and soon to be compulsory for all technology students) was developed through a writing across the curriculum philosophy: it was this philosophy which strongly informed the need for the web-based testing facility described in this paper. This discussion is in two parts: the first considers the historical development of the mastery testing in this paper while the second explores the system which allows us to test 770 students online across two campuses.

The College of Sciences had long been aware of the importance of communication skills as a requirement for graduates. College surveys of employers consistently showed that what employers were looking for was not industry-related subject knowledge, but, rather, what we might fashionably call "life-long learning skills", including group skills, leadership, problem solving and, most consistently, communication (both written and oral) skills. In fact, this picture is not confined to the College of Science at Massey University in New Zealand but is confirmed as a broader problem in employer surveys in England (see, for example, Merrick, 1997), Australia (Illing, 1994; Reid, 1997, Baldauf; 1997), and New Zealand (Andrews, 1995; Cox and Pollock, 1997), where employers prioritised – and found lacking – the communication skills of graduates seeking employment.

Until 1996, two different approaches had been taken by the College of Science to address the communication skills of students. By far the most common approach in the different programmes was to legislate that "advanced level communications skills" should be integrated into all courses; in reality, because no objectives were set, and because staff were not necessarily aware of how to teach communication skills, nothing happened: the issue of communication was not addressed or, if it was, it was addressed in an ad hoc, idiosyncratic manner. The second approach was taken by the horticulture programme, which made a writing paper, taught through the English Department, compulsory for all their majoring students.

This second approach was ground breaking in that it directly addressed the issue of teaching communication or writing skills to undergraduate science students. The difficulty with this approach, however, was that the writing paper which the students were required to take was teaching inappropriate writing styles. The paper was focused on essay writing (while the horticulture students were required to write reports) and the style of writing taught (i.e., the seamless development of an argument) was simply not appropriate to the writing requirements of horticulture.

In 1996 a new approach was taken: the College would teach these skills itself, through a first year writing course, taught by College of Science staff, in consultation with a PhD student from the Department of English working in the field of writing across the curriculum. The paper took time to evolve, but in time it became an entrenched part of the degree, and Science teachers found that they were, indeed, the right people to teach the styles and genres of scientific writing. While the paper was originally only compulsory for applied science students taking a the BApplSc degree, this requirement was soon extended to students taking a BSc or BMLS degree, and this year is extended to the BTech degree.

However, a major difficulty remained. Many of our students were poor writers, in that their understanding of the basics – grammar, spelling, punctuation – was poor. And while academic staff teaching this course were comfortable teaching report writing, and could *recognise* incorrect writing, they could not explain to their students *why* their writing was incorrect. We attempted to deal with this by including a single tutorial on aspects of grammar, which we taught

our tutors to teach, but this proved unsatisfactory – the capable students were bored and the tutorial did not come close to meeting the needs of the poor writers.

The solution we arrived at was to teach these skills using mastery tests in key areas: punctuation, grammar (English and Science was the euphemism we used!), and paragraphing. We designed open-answer paper-based tests in each area (four tests in each area). Students were able to read through a set of material on each of the topics, complete a set of practice exercises and, when they were confident that they understood the material they could come and sit the tests, as often as they needed to for six weeks. Those who were struggling were able to attend a series of intensive workshops in each of the three areas of study. The pass rate was set at 80% and students were required to pass these tests to pass the course, although no marks for the tests were included in the students' final assessment.

The mastery tests solved our problems in three ways. First, they were a way of dealing to different skill-levels: those students with high level skills would need to spend little time studying for the tests, while those with poor level skills could be provided with intensive teaching by a single teacher trained in that field. Second, our science teachers would not have to re-train as teachers of grammar, and third, we could say, with some confidence, that students had reached a certain level of skill by the time they had passed the course.

Despite the inevitable teething problems, the tests worked well. We found that we had underestimated the amount of teaching and practice most of the students actually needed in this area. One of the tests we decided was too difficult (after extensive consultation with people who specialised in the field of writing) so it was rewritten to a more realistic level. Some students, we discovered, had no idea how to take tests, so we had to include test taking skills in our course. Others had the erroneous view that if they took as many as five tests in an hour for three sessions per week over six weeks, then they were statistically likely to pass by chance – thereby showing a grasp of probability that sent the science teachers into despair. But once we had solved these problems, and in so doing gained a greater understanding of our students and their needs, the mastery tests worked well.

A serious difficulty arose, however, when the course was extended to reach more students. When only the BApplSc students were taking the course, we could manage the marking of the tests; it was time consuming, and only a couple of the teachers on the course could mark them (in the interests of consistency), but it was manageable for 140 students. When the BSc and BMLS students joined the course, and when the course had to be offered on multiple campuses, lifting student numbers to 770, the marking of these tests by hand was clearly impossible. We either had to find a new way of teaching those skills or we had to find a different way of managing the tests.

We chose to find a different way of managing the tests, but as we explain later in this paper, this decision ultimately led to us finding a new way of teaching these skills. The second part of this paper describes our online approach to testing students.

We now manage the tests using a custom-designed web-based system operating under Microsoft's Active Server Pages (ASP). ASP is Microsoft's support framework for server-side scripting, enabling the mixing of HTML with in-line scripting using JScript or VBScript. Although ASP can be used to produce simple HTML pages, one of its major design features is that web pages can be 'tied' into data stored in databases. ASP itself is not a scripting language - it only provides the environment that processes scripts.

Overview of the testing system

Students sit the mastery tests in specified computer labs at specified times. The tests are invigilated: we find that two tutors can easily manage a 50-seat computer lab. After logging into the class network environment and accessing the website with their browsers, students enter their student identification number, a password, select the type of mastery test they wish to attempt, and start the system. Students are permitted one attempt at each of the three different types of mastery each day. Provided security criteria are met (discussed in the next section), a mastery test is generated. Each generated test is unique for each student; an Access database is queried for a random selection of 20 questions with no repeats, and a web page containing those questions returned to the student's browser. Some of the mastery tests are comprised totally of multiple choice questions (MCQs) while others involve a mix of MCQ and long answer questions (LAQs) entered into form windows (Fig.1). When he or she has completed the test, the student submits their answers to the server which 'marks' the MCQs, returning to the student's screen the student's name and identify number, their actual mark and whether this constitutes a pass or fail, a list of the types of errors made (if any), and instructions on how to have the results validated (Fig. 2). For those tests involving LAQs, the student's answers are also printed to the screen. Students must print the web page and give it and their student ID card to one of the invigilating tutors who checks that the student in front of them matches the photograph on the ID card and that the ID numbers on the printed page and ID card also match. The printed sheets are initialed and retained by the tutors for subsequent checking against the database records. A tutor marks the LAQs and enters the student's final grade into the database from the administration interface of the web site.

Security

In addition to its testing function, the website acts as an online noticeboard for the class, and for administrative functions for the teaching staff (discussed in the next section). Hence, while we had the option of 'confining' access to the site to specific computers and with this, considerably reducing our security risk, the need to provide easy access to the site's other functions has meant that we have had to install a series of security checks before the mastery tests are generated (Fig. 3).

When a student logs into the site and generates a test, the system first checks the entered password. If the password is not the administrator's password, the time and campus selected are then checked, as students can only generate tests during specific hours at the different campuses. If the test is being generated 'out of hours' the student is denied access, their student ID is entered into a 'sin bin' table in the database, and an informative email is sent to the site's administrator and the course's controller. If the test is being generated at the correct place and time, the system checks that the password is the correct password for the day. The daily password is given to the students at the computer lab by the tutor; if not, the system redirects the student to an appropriate informative page. If the entered password is correct, the system then checks that the student is enrolled in the paper at the selected campus. If there is no record of the student in the database, redirection to an informative page is made. The system checks that the enrolled student's ID number is not in the sin bin. If it is, the student is redirected to an informative page. If this stage is reached, the student must subsequently explain the 'out-of-hours' attempt to the tutor who will, if satisfied with the explanation, unblock the student's access to the tests by deleting their ID number from the 'sin bin' table (through the administration pages). The final check made in this series is whether the student has attempted the selected test that day. If not, the test is generated; if the student has attempted the same type of test, they are redirected to an informative page and an informative email (containing the student's ID, name, attempted test and time) is sent to the administrator.

Once the completed test is submitted for marking, the system re-checks that the student has not attempted the test type previously that day before it grades the test. This check is to overcome the 'back button" problem. If, after submitting and failing the selected test, the student attempts to back through the browser's page cache, they will reach the previously generated test. All their previous answers are wiped (through an "onload" javascript routine) in an implicit attempt to discourage a repeat attempt, however should they repeat the test, the second check on their current day test history will block their attempt. The student will be redirected to an informative page, their student ID is entered into the 'sin bin' table (thus blocking all further attempts to generate any tests until cleared by the administrator) and an informative email is generated and sent to the administrator.

As previously mentioned, when a student passes a test, they must print out the page detailing their pass and give it and their student ID to the tutors present in the laboratory. Not only is this step necessary to ensure that students are siting their own tests, but it also protects against students who access the mastery tests during permitted hours from computers outside of the prescribed lab.

As most students only take about 10-15 minutes to complete a mastery test, they are free to leave the laboratory when they have finished. It is conceivable that under these conditions, an unscrupulous student could quickly attempt a test, leave the lab armed with the daily password and generate and either complete a test unsupervised, or generate several tests

and store them at another computer. We guard against this possibility in two ways. First, the number of initialled printouts collected by the tutors in the labs is compared against the database's count of passed tests for the day. Any discrepancy can be subsequently quickly traced to a particular student. Second, the system maintains a count of generated and assessed tests; a discrepancy between these two numbers indicates a possible problem.

In the three semesters of using this testing facility we have never encountered a problem as outlined here. However, we will tighten this potential security loophole in the next version of the system by generating, at the time a student generates their first test of the day, a session cookie containing a random string. The string will be stored in the database and the contents of the cookie will be checked against that string at each subsequent test generated by the student on a given day. If the strings do not match, it will mean that the student is attempting the tests from different machines and no tests will be generated.

Online administrative support

The development of the online testing system has stimulated considerable development in other parts of the site as tutors have gained confidence in the system and its potential. Tutors have controlled access to a secure online administration component of the site within which they can enter student results from other parts of the course, and retrieve their students' progress in the mastery tests. Being able to identify those students having difficulty with the tests gives the tutors the opportunity to direct those students to the Student Learning Centre and other learning support available on campus. An online data entry page allows tutors to add new or edit existing test questions in the main database. Administrators can enter new students to the database, reallocate students between tutors and update class rolls, retrieve the daily password, view overall class performance statistics, and restore access to the tests of those students 'trapped' in the sin bin as a result of previous misdemeanours on the site.

Future developments

We are currently using Microsoft Access as our database, and with the numbers of students accessing the site, are rapidly getting close to the functional limit of the database. In 2001, we will be moving to SQL Server 7. The versatility of the website has initiated other online developments to support our students' learning in communication. An Online Writing and Learning Lab (OWLL; http://owll.massey.ac.nz) is currently being developed under the ASP umbrella to assist not only our students in our communication course, but the wider student community. For our students, the online exercises in punctuation, grammar and spelling available on the OWLL will be closely tied to the online testing system. For example, links to appropriate OWLL resources will appear on the results pages of the testing website.

One of the questions we have debated is this: how can we know that students who pass these multichoice tests can transfer the skills they have learned to their own writing? This is a good question, and difficult to answer – indeed, at this stage we have only anecdotal evidence to support our response. What we

have noticed is that students who have studied for these tests are often overheard discussing the use of, say, punctuation, and in doing so they employ the terminology we have taught them and use to it to problem solve in relation to their own writing. Many of our tutors report overhearing conversations between two or more students about whether or not to include, for example, a comma in a sentence in one of their assignments. When you hear a student saying “no – I don’t think we should include a comma, look, it just doesn’t sound right” and another say “but, no – remember that when you join two complete sentences with that kind of conjunction, you have to put a comma in – and they are both complete sentences – look!” you know some kind of transferring is happening, for some students. The extent to which this is happening is not something we have yet attempted to determine. Nevertheless, the system described in this paper is providing a context in which these crucial skills can be taught and tested to an ever increasing class, in a way that is administratively manageable and ensures prompt feedback to students and teachers alike.

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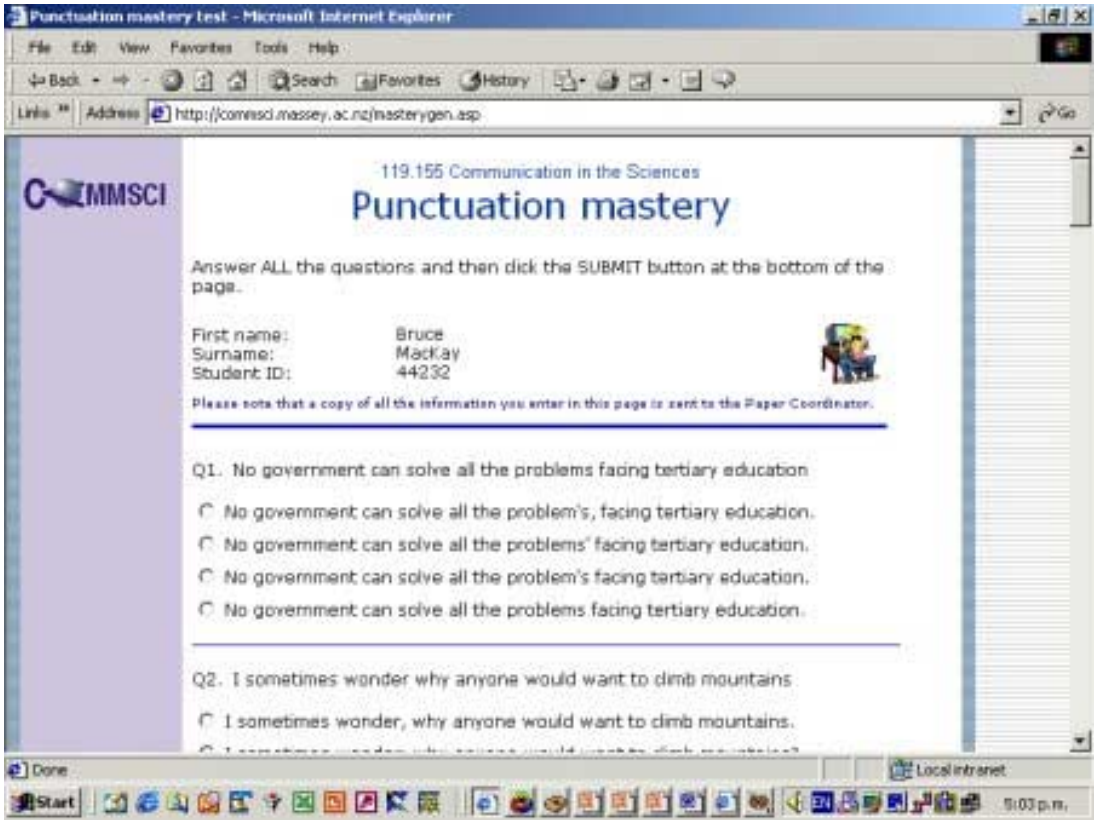

Figure 1 Typical layout for multiple choice questions

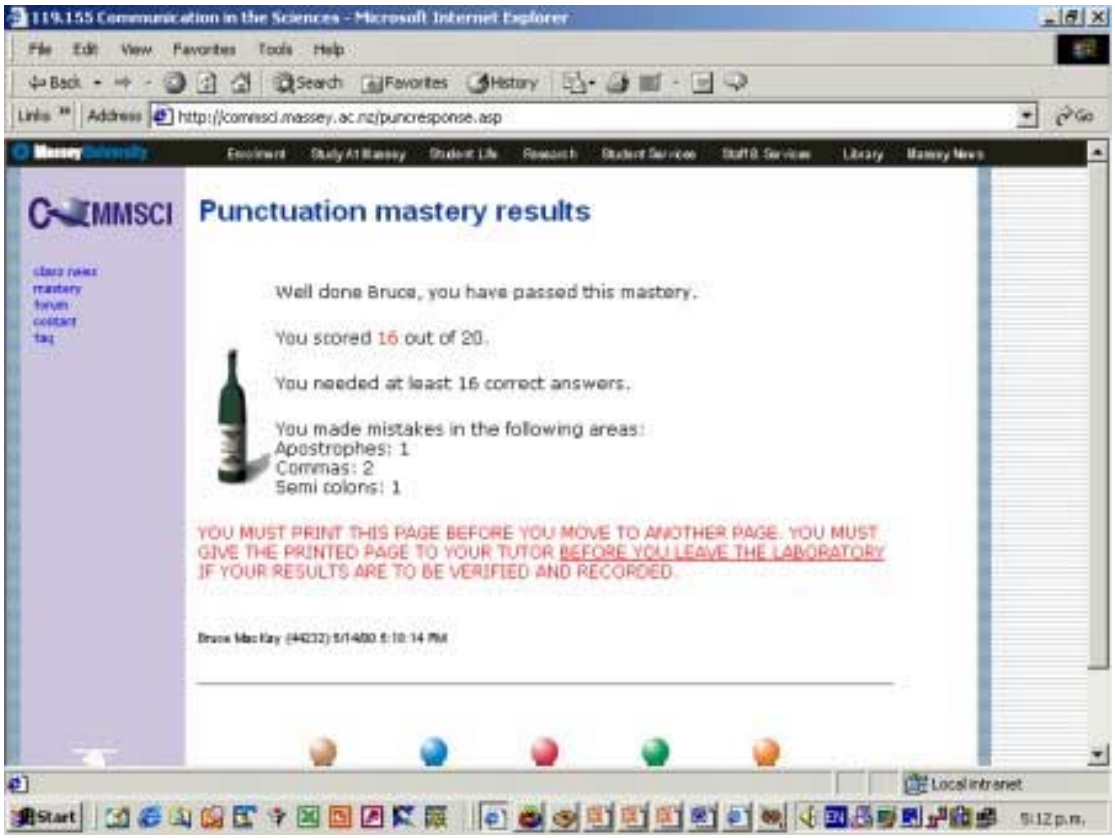

Figure 2 Results and feedback page

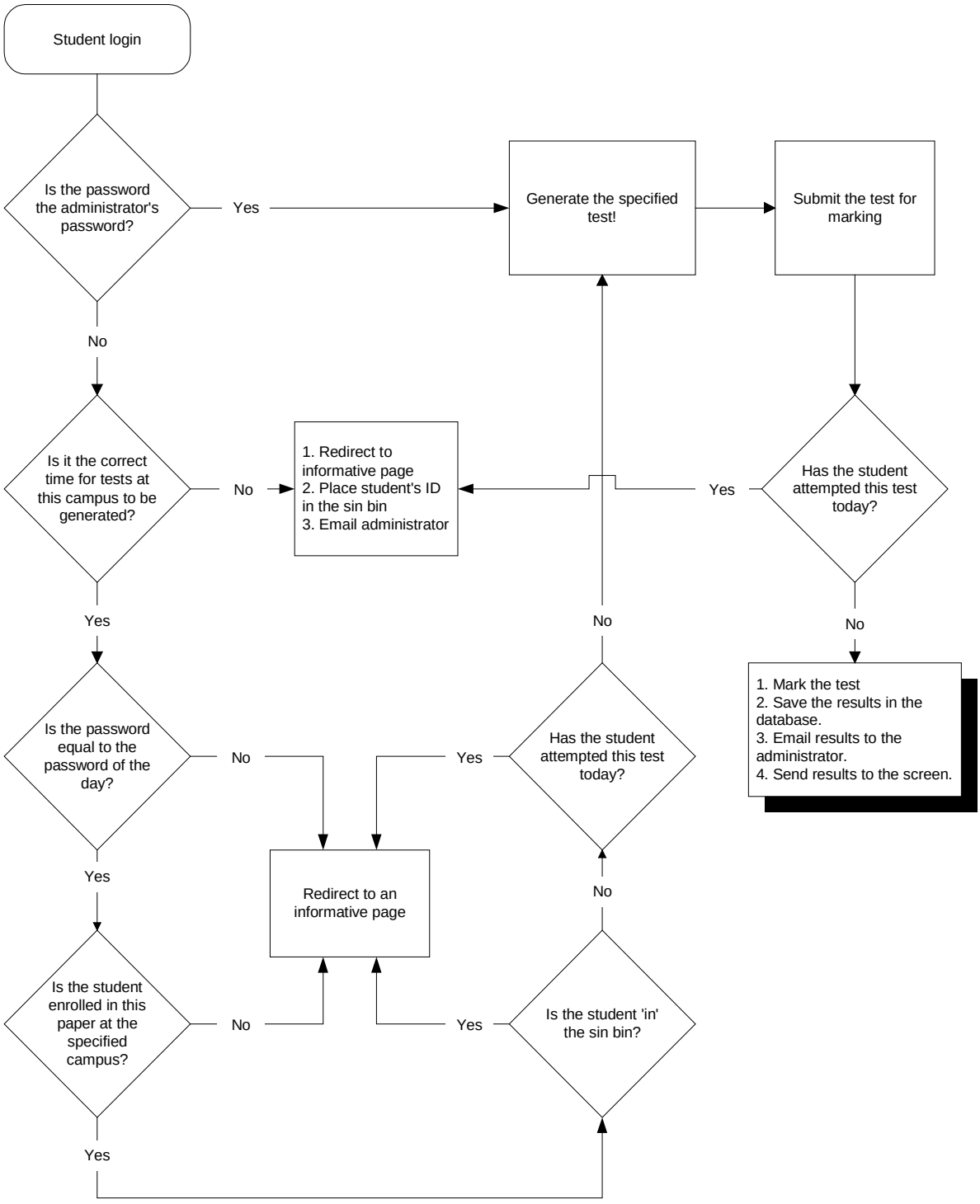

Figure 3 Schematic of security sequence involved in generating and marking a mastery test