

***A Comprehensive Online Mathematics Assessment,  
Placement and Exit Testing Program***

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Although we are the flagship university of the state of Nevada and have what appear to be reasonable admission requirements, the fact is that we admit a large number of students that are poorly prepared in mathematics. Among these students are ones who would like to pursue a career in engineering or science, including teaching math or science in the public schools. We are faced with a twofold problem of placing them into math courses for which they are adequately prepared while being certain that they have had an adequate chance to correct deficiencies before being placed. Without a system that addresses both of these problems, there is a risk of students becoming discouraged and perhaps changing majors.

Another serious consequence of inadequate placement of students in mathematics classes is that the curriculum in some courses has become more and more watered down over the years. Instructors who are forced to cope with a rather sizable contingent of under-prepared students tend to spend far more time on remedial subject matter and less time on the "meat" of the course. This is illustrated in our Math 128 course (precalculus algebra and trigonometry) where the typical syllabus now allots 17 days, or 23.6% of the course (including a review and exam) to chapter 1 - the great bulk of which is remedial coverage of topics such as straight lines and exponents.

Another problem is that high school students sometimes come to the university with an unrealistic idea of what will be required of them to get into the mathematics course they would like. When they meet with disappointment in their first university experience with math, it is quite discouraging for them. To avoid this, early intervention would be helpful.

Finally, and as importantly, we need systematic assessment based on articulated outcomes as an important means of strengthening both our curriculum and instruction.

We have recognized this in the mathematics department, and our University's accrediting agency has raised assessment as an issue that the entire campus must improve on.

Here are properties we plan for our proposed system, which we will address in the following narrative.

- Randomized automated test construction so every test is different.
- Automated scoring, record keeping and reporting of scores.
- Ability to retake the test a specified number of times.
- Availability of practice tests.
- Tests are free.
- Availability of online explanations of concepts and solutions for students who require more assistance.
- Tests are accessible to high school students and others away from campus.
- Test results are used for outcomes-based assessment and to improve instruction.

The core of the software needed to accomplish all the testing proposed in this project has already been developed under NSF Grant DUE 9980687, *Online math testing, remediation and assessment strategy for engineering majors*. This was a proof of concept grant awarded to the two authors. It is currently being used to test engineering majors. See <http://devnull.math.unr.edu/webtest>.

The program presents questions that are randomized in one of two ways: a problem may have randomly generated components such as coefficients in an equation, or problems may be selected at random from a database. In any case, each time a student encounters a test it will look different from previous tests. Problems may be multiple choice, but the program also parses formulas so that free responses can be accommodated.

Currently, questions are input using LaTeX syntax and are displayed on the client machine using Java applets. We plan to use MathML when popular browsers support it. The program also keeps detailed records in a relational database so that all sorts of queries can be answered. The capabilities are similar to those of the E-grade program authored by John Orr. Unfortunately, that test is expensive unless one adopts books used

by certain publishers, who may also impose licensing agreements that limit the ways one can use it.

Two advantages to our online system are that it will be free once it is ready and individual institutions can custom design the placement tests for their own environments. For example, one of our popular courses is Math 120, commonly referred to as "math for liberal arts majors." Most placement tests address proficiency in algebra or other conventional skills, which may not be entirely appropriate for an eclectic course such as this. The instructors who teach the course could design the placement exam so that it is appropriate for the intended audience.

As a trial run, in the spring of 2002 semester all 13 sections of Math 128 (precalculus algebra and trigonometry) agreed to administer a 12 question pilot version of the online placement test during the first week of class. Students could take the test as often as five times and their highest score counted toward their grade in the course. 483 students took the test. 196 took it once, 167 took it twice, 81 took it 3 times, 32 took it 4 times and 6 took it 5 times. We had set a score of 9 out of 12 as the level of "success" meaning that any student scoring less than 9 would be advised to drop back to a lower level course. The average score on the first try was 6.56. Among those who took the test more than once the average of the highest scores was 9.16. It is our hope that by giving students more than one try on placement tests they will succeed in getting up to speed. (Even so, it is sad that only 57.5% ever got 9 or more.)