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### ***Online Readiness Testing and Assessment***

We discuss a system of web-based readiness examinations for lower division mathematics courses and how they have been used to assess and improve our curriculum and teaching. Funding from NSF Grant DUE 0206801 is gratefully acknowledged.

Math 128 is Algebra-Trig (precalculus)  
Math 124 is College Algebra  
Math 120 is "Math for liberal arts majors"  
Math 176 is Business Calculus  
Math 181 is Calculus

The University of Nevada historically has admitted a significant number of students who 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.

A serious consequence of inadequate placement of students in mathematics classes was that the curriculum in some of our courses became 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 more time on remedial subject matter and less time on the "meat" of the course.

**In 2001 this was evident in our Math 128 course (precalculus algebra and trigonometry) where the typical syllabus allotted 17 days, or 23.6% of the course (including a review and exam) to chapter 1 - the great bulk of which was remedial coverage of topics such as straight lines and exponents.**

We also found that ACT and SAT scores were some indication of success:

In the 2000-01 academic year 750 students were enrolled in Math 128 (precalculus algebra and trigonometry). Of these, 294 (39.2%) had a quantitative ACT score of 24 or more or an SAT of 560 or more (our recommended cutoffs at the time). Their GPA was 2.40 vs. an average GPA of 1.86 for all other Math 128 students. (17.7% of students in Math 128 in 2000-01 did not have either an SAT or an ACT score.)

There was (and still is) a big problem with remediation: Math 096 is a zero-credit intermediate algebra course.

Math 096 enrollment in academic year 2000-01 was 384. UNR's enrollment for academic year 2000-01 was 12,902.

Math 096 enrollment in academic year 2004-05 was 513. UNR's fall 2005 enrollment was 15,469.

Thus UNR enrollment increased by 19.9% while the Math 096 enrollment increased by 33.6%.

One hopes that by making high school students aware of our expectations and getting them through a placement exam we can reduce this remedial flood.

A problem related to remediation is that high school students sometimes come to the university with an unrealistic idea of what will be required of them to get into, and successfully through, 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 and reduce remediation, early intervention would be helpful.

We tried commercial placement testing software but found it lacking. We needed a system that places students into math courses for which they are adequately prepared while allowing them a chance to appeal their placement and to correct deficiencies – preferably free of charge. With 12,000 students, this had to be done without placing a burden on our staff with numerous requests for waivers and exceptions.

As a result, with the assistance of NSF Grant DUE 0206801, we have written software and implemented a web-based testing system that accomplishes these goals. Here are some properties of our system:

- 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.
- Availability of online solutions for students who require assistance.
- Tests are free.
- Tests are accessible to high school students and others away from campus.
- Test results are used for outcomes-based assessment and to improve instruction.

Our policy on calculators is that students may use the online calculator that comes with Microsoft Windows. They may not use their own calculator.

Our project was funded in early 2002. The results follow:

Previously, students were allowed to enroll in any math course with no placement or screening. For those who felt they might not be ready for Algebra-Trig Math 128, College Algebra Math 124 was listed as an acceptable prerequisite.

Since many people were expecting to be able to use Math 124 to get into Math 128, we asked all Math 124 instructors to give the Math 128 readiness test at the end of their classes as an exit exam in Fall 2002. These exit tests were given in all sections.

**In fall 2004 283 students took Math 128.  
117 (41.3%) had taken Math 124.  
209 (73.9%) of them either passed 124 or the 128 exam.**

**In fall 2004 170 students took Math 176.  
105 (70%) had taken Math 124.  
116 (77.3%) of them either passed 124 or the 128 exam.**

A total of **506** students took the Math 128 readiness exam in **Fall 2002**. **434** (85.8%) of these took it in Math 124 as an exit exam while **72** (14.2%) did not take it in the context of Math 124.

42 Students *not in 124* passed the exam (58.3%) in three or fewer tries.  
30 Students *not in 124* failed the exam (41.7%) in three or fewer tries.

Overall:

392 Students passed the exam (77.5%) in three or fewer tries.  
114 Students failed the exam (22.5%) in three or fewer tries.

Math 124 Fall 2002 Exit Exam Scores. 12 questions.

Attempt #	% Failed (8 or less)	# Failed (8 or less)	Average / 12
One	74.9%	326	6.69
Two	33.8%	147	8.64
Three	11.0%	48	9.68
Four	2.8%	12	10.41
Five	0.9%	4	10.26
<b>Max</b>	<b>19.3%</b>	<b>84</b>	<b>9.88</b>

**Spring 2003:** Entrance into Math 128 was enforced by the registrar for the first time. (Enrollment began in the latter part of the Fall 2002 semester - thus the first cohort of students for whom placement rules were enforced were those enrolled for in Spring 2003.) Students attempting to enroll in Math 128 were blocked from enrolling unless they satisfied one of the three criteria: SAT score of 610, ACT score of 27 or readiness exam score of 11/15. We allowed no exceptions to these rules. Math 124 exit tests were again

given in all sections. (Recall that the exit exams are the same as the Math 128 readiness exams.)

A total of **399** students took the Math 128 readiness exam in Spring 2003. **286** of these took it in Math 124 as an exit exam while **113** did not take it in the context of Math 124.

Of the 286 Math 124 students who took the test, 177 (61.9%) passed with 9 or higher in 3 or more attempts. *124-Exit-May6-2003.xls*

The overall pass/fail rates were as follows:

230 Students Passed (57.6%)

169 Students Failed (42.4%)

During the **Summer of 2003** we revised the Math 128 exam by increasing the length from 12 to 15 questions. The passing score was changed from 9/12 to 11/15. The practice exam was also revised to 20 questions based on student performance and feedback from instructors and our panel of high school teachers. One of our major changes was to include online worked out solutions for most of the questions.

A total of 471 students took the readiness exam in **Fall 2003**. 430 of these took it in Math 124 as an exit exam while 41 did not take it in the context of Math 124.

The pass/fail rates are as follows:

374 Students Passed (79.4%)

97 Students Failed (20.6%)

Catalog changes were approved to make ACT, SAT or readiness exam scores the sole prerequisite for lower division courses.

In **Spring 2004** a total of **212** students took the Math 128 readiness exam. **152** of these took it in Math 124 as an exit exam while **60** did not take it in the context of Math 124.

The pass/fail rates are as follows:

123 Students Passed (58%)

89 Students Failed (42%)

Enrollment for the Fall 2005 semester takes place during the latter part of the Spring 2004 semester. The registrar began enforcing the new prerequisites for Math 176 (business calculus) during this period. (These are the same as for Math 128, namely SAT score of 615, ACT score of 27, or a readiness exam score of 11/15.) The catalog was changed to reflect this new prerequisite for Math 176.

We created a draft version of an exam for Math 120 and Math 124 called the Basic Algebra Readiness test or BART. The cutoffs for the BART were based on an assessment of the main skills we wanted students in the courses to have.

*Factoid: Assuming 5 choices for each multiple choice problem, the probability of getting 8 or more out of 14 by guessing is about 0.0024. Most of ours have 6 choices. In this case the probability is about 0.0007.*

***Data for spring 2002 through fall 2003: In Math 120, 30.6% of the 1,636 students met the ACT/SAT cutoffs. 45.7% did not meet these cutoffs, and 23.7% had no score. In math 124, 31.9% of the 1,751 students met the ACT/SAT cutoffs. 54.4% did not meet these cutoffs, and 13.8% had no score.***

*In Math 181, from spring 2002 through spring 2003 18.2% of the 1,141 students met the ACT/SAT cutoffs. 63.2% did not meet these cutoffs, and 18.6% had no score.*

Clearly a significant number of students in these classes did not meet the minimum criterion we had set for placement.

For some time we have had common finals in Math 096. As of fall 2004 we allow student performance on this test to substitute for the online placement exam. A score of 70% or higher gives an automatic “pass” and placement into 120 or 124. A score of less than 65% gives an automatic “fail.” A score of 64-69% allows instructor to award “pass” or “fail” at his or her discretion.

In **Fall 2004** we ran the new BART exam through all the Math 120 & 124 sections. Instructors were requested to have their students take the practice exam in the math center computer lab. They could take the test up to three times and were awarded whatever percentage they made on the test. It counted count up to 4% of their grade in the class - more or less like a big quiz.

Math 120 results:

In early Fall 2004, 559 Math 120 students took the test 829 times. (1.5 avg).

356	63.7%	took it once
136	24.3%	took it twice
67	12.0%	took it 3 times

65.8% got 50% or less 20.9% got 67% or more.

Out of the 829 tests given, here are the percentages of correct responses to each question

Question 1	83%	From a crate of $x$ eggs you are able to fill $y$ cartons with $z$ eggs left over. How many eggs does each carton hold?
Question 2	64%	If the decimal 0.175 is expressed as a fraction with a denominator $D$ then the numerator will be:
Question 3	41%	products of powers
Question 4	55%	$(6 + 5y)^2 = ?$
Question 5	24%	find the length, $L$ , of the cardboard rectangle
Question 6	54%	$-5x - 5(-5 - 5x) = 10$
Question 7	21%	man and a dog race
Question 8	16%	slope and $y$ -intercept of the line
Question 9	60%	marked up 5% last week and didn't sell
Question 10	55%	evaluate $x^2 y - y - 2(x - z)$ if $x = -4$ , $y = 5$ and $z = -3$ .
Question 11	44%	add fracs / $\sqrt{y}$
Question 12	46%	add fracs
Question 13	50%	Evaluate $3a - (b - 2c)^2$
Question 14	38%	1 incorrect. Which one
Question 15	38%	1 correct. Which one
Question 16	27%	$1/w + 1/s =$
Question 17	47%	$(2b^3 3y^4)^2$ simplifies to which of these?
Question 18	14%	form $Cz^a w^b$ .

Math 124 results:

In early Fall 2004, 675 Math 124 students took the test 1135 times. (1.68 avg).

352	52.1%	took it once
186	27.6%	took it twice
137	20.3%	took it 3 times

39.4% got 50% or less 40.7% got 67% or more

Out of the 1135 tests given, here are the percentages of correct responses to each question

Question 1	86%	From a crate of $x$ eggs you are able to fill $y$ cartons with $z$ eggs left over. How many eggs does each carton hold?
Question 2	69%	If the decimal 0.175 is expressed as a fraction with a denominator $D$ then the numerator will be:
Question 3	55%	products of powers
Question 4	70%	$(6 + 5y)^2 ?$
Question 5	27%	find the length, $L$ , of the cardboard rectangle
Question 6	68%	$-5x - 5(-5 - 5x) = 10$

Question 7	31%	man and a dog race
Question 8	25%	slope and y-intercept of the line
Question 9	68%	marked up 5% last week and didn't sell
Question 10	62%	evaluate $x^2y - y - 2(x - z)$ if $x = -4$ , $y = 5$ and $z = -3$ .
Question 11	60%	add fracs / sqrt(y)
Question 12	64%	add fracs
Question 13	55%	Evaluate $3a - (b - 2c)^2$
Question 14	46%	1 incorrect. Which one
Question 15	49%	1 correct. Which one
Question 16	37%	$1/w + 1/s =$
Question 17	62%	$(2b^3 - 3y^4)^2$ simplifies to which of these?
Question 18	30%	form $Cz^a w^b$ .

Partly because of the concern of the university administration, we decided to give common finals in Math 124 in **Fall 2004** and use it as a readiness test for 128 and 176. Students who made less than 60% could not proceed to Math 128 or 176 unless they passed the online readiness exam.

In **Fall 2004** a total of 471 students took the Math 128 readiness exam.

The pass/fail rates are as follows:

374 Students Passed (79.4%)

97 Students Failed (20.6%)

### **Spring 2005**

On Feb 3, 2005 we met with Math 128 teachers to tell them about the blocking and to encourage them to go faster through the early chapters (basically 1 -3 of Stewart's Algebra/Trig).

Conclusions:

Instructors in Math 128 and 176 told us they strengthened their syllabi following the blocking of enrollment. They are spending less time on the beginning material.

**Today – spring 2006 – we use Stewart's Algebra & Trig book. Five days (7%) are given to Chapter 1 and 14 days (19.7%) to Chapters 1 – 3. This is clearly an improvement.**

**In fall 2004 283 students took Math 128.**

**117 (41.3%) had taken Math 124.**

**209 (73.9%) of them had a "1" in M128 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In fall 2004 170 students took Math 176.  
105 (70%) had taken Math 124.  
116 (77.3%) of them had a “1” in M128 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In fall 2004 425 students took Math 181.  
163 (38.4%) had taken Math 128.  
(104 or 24.5% had taken Math 124.)  
98 (23.1%) of them had a “1” in M128 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In fall 2005 580 students took Math 120.  
39 (6.7%) had taken Math 096.  
189 (32.6%) of them had a “1” in M120 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In fall 2005 686 students took Math 124.  
25 (3.6%) had taken Math 096.  
130 (19.0%) of them had a “1” in M124 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In fall 2005 351 students took Math 128.  
115 (32.8%) had taken Math 124.  
268 (76.4%) of them had a “1” in M128 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In fall 2005 193 students took Math 176.  
128 or 66.3% had taken Math 124.  
168 (87.0%) of them had a “1” in M128 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In fall 2005 510 students took Math 181.  
172 (33.7%) had taken Math 128.  
(123 or 24.1% had taken Math 124.)  
139 (27.3%) of them had a “1” in M128 test field indicating a pass on the exam or a satisfactory performance in college algebra, Math 124.**

**In Spring 2000 189 students in Math 128 (72.7%) got a grade without any screening(\*)**



**Their GPA was 2.06.**

**In Fall 2000 381 students (78.1% ) got a grade in Math 128 without any screening(\*).**

**Their GPA was 2.17.**

**In Spring 2001 74.2% got a grade in Math 128 without any screening(\*).**

**Their GPA was 1.89.**

**In Fall 2001 74.8% got a grade in Math 128 without any screening(\*).**

**Their GPA was 2.31.**

**(\*) This means they did not have an adequate ACT/SAT nor did they make a B or higher in Math 124.**

**Between Nov 23, 2004 and Sept 8, 2005 693 students took the 128 exam 729 times. 388 (56%) got 11 or higher as their maximum score. 70 of these took Math 128 In Spring 2005.**

**Their GPA was 2.21**

**132 of those 388 took Math 128 in Fall 2005. Their GPA was 2.54.**

**42 of those 388 took Math 176 In Spring 2005. Their GPA was 2.9**

**62 of those 388 took Math 176 in Spring 2005. Their GPA was 2.9.**

Since syllabi were made more rigorous and GPAs did not decline went up we see this as a success.

Other observations: Some students were failing the readiness exam while making grades of C or B in Math 124. We believe that this may be a result of weaknesses in the way some instructors award grades. We believe it points to a need to increase supervision of TAs and part-timers.

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Based on the data collected from Math 128 readiness exams our statistician draws the following conclusions:

Beginning in fall 2006 math 128 will have common final exams.

We are now (spring 2006) ready to operate a readiness exam for Math 181.

**Cutoffs for admission to 120 are:**

- **SAT score of 510**
- **ACT score of 21**
- **Readiness exam BART score of 8/14 or higher.**

**Cutoffs for admission to 124 are:**

- **SAT score of 520**
- **ACT score of 22**
- **Readiness exam BART score of 10/14 or higher.**

**Cutoffs for admission to 128 are:**

- **SAT score of 610**
- **ACT score of 27**
- **Readiness exam score of 11/15 or higher.**
- **B or better in Math 124**
- **60% or higher on common final exam.**

**Cutoffs for admission to 181 are:**

- **SAT of 630 or higher**
- **ACT of 28 or higher**
- **Have credit for AP calculus - AB.**
- **Pass Math 128 (soon with C- or higher)**
- **Pass the Math 181 Readiness Test with 12/16.**