Elementary Algebra Teaching Community **Spring 2003**
Summary: Summative Assessment of Problem-solving and Skills Outcomes

PART I: Problem-solving

Problem-solving Outcome: Students will use mathematical reasoning to solve problems and a generalized problem solving process to work word problems.

Sampling design: From nine Math 25 sections taught by instructors participating in the Teaching Community, we chose a random sample of three students from each section. The sample was taken from students who were passing the course prior to taking the final exam. The sample contained 18 students. (Two of the eight instructors did not submit student work, so the sample did not contain students from three sections.)

Method: We wrote four problems that met the criteria for problem-solving in the DE Problem-solving Outcome. The four problems required students to apply concepts in a context, demonstrate conceptual understanding, explain their reasoning, and use multiple approaches. The four problems were also designed so that multiple strategies could lead to a solution; in this way, the problems were more than standard word problems. Every instructor put these four problems on his/her final exam. (#2, 3, 7, and 17 from the common final exam)

Technique: All four problems from each student paper were assessed holistically using a rubric written by the Teaching Community earlier in the semester. We began with a benchmarking exercise in which each instructor graded the same three papers. We then discussed the scores on these three papers and reached consensus. Next, each final was assessed independently by three instructors. If at least one of the three scores differed from the mean of the three scores by more than 0.5, that student's work was discussed by the whole group until consensus was reached. Otherwise, scores were averaged.

Summary: See rubric for description of scores

Stemplot of rubric scores

2| 5 represents an average score of 2.5

0	
1	
2	5 5 7
3	0 0 0 5 5 5 5 5 7
4	0 0 5
5	0 0 0
6	

Mean 3.6 Standard deviation .8
Quartiles: 2.5 3 3.5 4 5

Student Profile Based On The Mean Rubric Score:
A mean score of 3.6 indicates that the average student in this sample can complete some important components of the problem-solving task and communicate with sufficient clarity to get his/her idea across. Portions of work may be unorganized or difficult to follow. Some strategies may be unclear or inappropriate. At times, mathematical reasoning is not clear. There is evidence of applying relevant concepts and appropriate processes throughout, though implementation is only partially successful in some cases.

Observations: Instructors noted that nearly all students in the sample attempted every problem. Uniformly, the students did a good job defining variables and using multiple approaches when prompted. Very few papers explicitly demonstrated more sophisticated use of a general problem-solving process (e.g. stating givens and assumptions, giving estimates, checking). Generalizing other weaknesses was more difficult. Instructors noted that frequently a student performed inconsistently on the four problems, demonstrating good understanding in one setting and having difficulty with similar concepts in another setting.

Action: Instructors in the Teaching Community will focus more on problem-solving in fall 2003. The use of computer-aided instruction to teach procedural algebra skills will provide more class time for instructors to work on problem-solving and the other DE program learning outcomes. During the summer session, eight instructors met for 3-hours a week to write and discuss classroom activities that focus on conceptual development of algebra content and problem-solving. We will see if this increased classroom focus on developing problem-solving skills improves student performance.

PART II: Skills Outcome

Skills Outcome: Students will recognize and apply math concepts in a variety of relevant settings and demonstrate the math skills and knowledge necessary to succeed in subsequent courses.

Sampling design: From nine Math 25 sections taught by instructors participating in the Teaching Community, we used all students who were passing the course prior to taking the final exam. The sample contained 136 students from seven sections; 122 took the same final exam. (One instructor who taught two sections did not submit data.)

Method: We identified six content objectives fundamental to Elementary Algebra. Using the common final exam, we ranked problems (referenced in the table) by skill into three levels of difficulty. One instructor gave a different final exam but ranked his problems similarly.

Technique: Instructors tallied the number of students who made minor errors and the number who got the problem completely correct.

Level of Difficulty

	Low		***Medium***		***High***	
Skill	Minor errors	Correct	Minor errors	Correct	Minor errors	Correct
Solve linear equations Final exam: low=1a, med=1b, high=1f	16/122 13%	102/122 84%	24/122 20%	86/122 70%	35/136 26%	61/136 45%
Find the equation of a line Final exam: low=18, med=2, high=7	8/122 7%	90/122 74%	33/136 24%	76/136 56%	44/136 32%	62/136 46%
Solve quadratic equations Final exam: low=9, med=1e, high=1g	31/122 25%	71/122 58%	30/122 25%	67/122 55%	43/136 32%	68/136 50%
Solve a linear inequality Final exam: med=1h	XXX	XXX	37/122 30%	59/122 48%	XXX	XXX
Simplify polynomials: add/subtract Final exam: low=11, med=12	12/136 9%	106/136 78%	40/136 29%	82/136 60%	XXX 3/14 21%	XXX 11/14 79%
Laws of Exponents Final exam: low=15a, med=15b	27/122 22%	57/122 47%	35/122 29%	49/122 40%	XXX 4/14 29%	XXX 10/14 71%

Observations: In all skills at all levels of difficulty, over 69% of the students could either perform the skill perfectly or with only minor errors. This sample of students had strengths in solving linear equations (without fractions), finding the equation of a line from two points, and simplifying polynomials. If we demand complete accuracy, we see weaknesses in solving linear equations with fractions, finding equations of lines from verbal descriptions, solving linear inequalities, and using the

laws of exponents to simplify expressions. In all other skills at all levels of difficulty at least 50% of the students performed the skill without errors.

Action: In an attempt to improve students' procedural algebra skills, the Teaching Community is experimenting with computer-aided instruction in fall 2003. With the PHIM-2 software, students will be able to choose from a variety of instructional methods, receive immediate feedback, and work problems until they reach mastery (defined as 85% correct in a given problem set). We will see if computer-aided instruction improves students' skills.