Final Report
Mathematics Supplemental Instruction
Faculty Inquiry Group
Summer 2009

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Executive Summary:

We developed plans for supplemental instruction workshops and guided learning activities with the goal of improving the success rate in our basic skills math courses. This program is designed to help students master the course material and also address deficiencies that many of our students have. The instructors will send individual students to a workshop or guided learning activity appropriate to the needs of that student. The program will be under the direction of the TLC and located in BONH-207. For the F09 semester we decided to concentrate on Math 060. Adequate funding and administrative support for this program will be essential for its success.

Introduction:

Our purpose is to improve the success rate of our students in basic skills math courses. Many students at this level do not know how to make best use of the resources already available (such as tutoring and office hours) and need a more structured program of supplemental instruction to be successful in these classes. Frequently they have deficiencies in certain skills which should have been mastered before entering the course. (For example, they may have difficulties in algebra because they have trouble doing basic fraction problems.) But our present courses are so packed with material that there is little time for an instructor to actually review these topics during the regular class. For this reason we have planned a series of workshops and guided-learning activities which will assist many students at this level. The course instructor will send each student to an appropriate workshop where they will participate in a lecture/discussion about the topic, complete worksheets or other materials to master the concepts, and receive individualized instruction as needed. The workshops will be taught by faculty members or specially trained TLC tutors. For those students unable to attend a workshop at the scheduled time, guided learning materials will be available. Students may also be allowed to retake a different version of one or two course exams to improve the grades. (The suggested policy is for the original score and the new score to be averaged). For the F09 semester we decided to concentrate on Math 060. This is a pilot program which we hope will be expanded in the future to cover all of our basic skills math courses.

Methodology: The proposed program is similar to successful programs at other colleges. For the F09 semester this will be considered to be an experimental pilot program. At the end of the first semester we will compare success rates in the participating sections with the other normal sections and get survey results and feedback from instructors. We will also monitor the use of resources (such as the number of tutors required and classroom space needed) so that the program can be successfully scaled-up in the future to include all our basic skills math courses (025, 026, 058, 059, 060, and 070).

Findings:

During our meetings we needed to consider the following:

1. The instructor's role: This program will not be very effective without the active involvement of the course instructors. Simply making the resources "available" to students will not mean that the students actually make use of the resources. Only a few students in these classes actually go to the instructor's office hours or to the TLC for the free tutoring which is already available. Participation in the workshops needs to be required by the course instructor and made a part of the student's grade otherwise the student probably won't attend.

2. Math 060: Since this will be a pilot program for the first semester, we decided to concentrate on Math 060 (Elementary Algebra). Although students in all 060 sections and any other math course are welcome to participate, there will be not more than five 060 instructors participating in F09. The reason for this is that it requires a significant amount of effort and extra time commitment on the part of the chosen instructors and the Math 060 coordinator to incorporate this program into the actual course. We also want to have a control group which will be the "normal" 060 classes to which we will compare results. Collette Gibson is the Math 060 coordinator, so she can effectively implement and monitor the program with the instructors.

3. Workshop topics: We considered various topics which are, in our experience, very important to the success of students in Math 060. To keep the program manageable, we decided to concentrate on these topics: applications. word problems, graphing, exponents, factoring and rational expressions. There will also be workshops on topics such as arithmetic with fractions which the student should have mastered in a previous course but often hasn't.

4. Workshop schedule: Collette has constructed a schedule for the workshops which will be coordinated with the 060 syllabus and make effective use of the available workshops. (See appendix for tentative workshop schedule).

5. Policies and procedures: We have considered various policies such as the maximum number of re-takes of exams, the amount of the course grade that will be counted, what if a student is unable to attend due to time conflicts, etc. Syllabus statements: These policies need to be written into each instructor's syllabus. While each instructor should have some flexibility in implementing the policies, we need to be reasonably consistent for all sections. (See appendix for sample syllabus statements and policies.)

6. Pretest: We have written a pretest to be given to all students during the first week of the 060 class. The pretest will help identify student strengths and weaknesses and allow the instructor to send the student to the appropriate workshop if help is needed. (See appendix for sample pretest.)

7. Materials: Members of the FIG have been writing workshop materials and guided learning activities for each of the topics. (See appendix for outlines and sample materials.)

8. Changes to BONH-207: We have worked on modifying the room to be more conducive to learning. The present computers have been moved from the center of the room to the north and south walls and the tables and chairs moved into the middle of the room. A second white board has been requested for the west wall. The present LCD projector needs to be connected to a computer for the instructor's use.

9. Future changes to course outlines: As this program expands, it may be advisable to incorporate supplemental instruction into each course outline.

10. Name for program: There has been a lively discussion within the math department on a name for this program. The most popular name among the math faculty is Supplemental Instruction for Gaining Mastery of Algebra and Arithmetic (SIGMA) and Math Achievement Center (MAC).

Conclusions and recommendations:

The program will initially be located in BONH-207. This room is also used as a resource by the mCAL (math Computer Assisted Learning) program. It is important that the planned workshops are coordinated with the mCAL classes so as to not interfere with the already successful mCAL program. The TLC will be responsible for hiring and training the tutors and instructors, maintaining the materials, administering tests, etc. The support and feedback from the Math Department faculty has been overwhelmingly positive and supportive. If this program is as successful as it should be, we will see a marked reduction in the number of students failing and having to retake these courses. A committee of mathematics department faculty members should oversee this new program and report on its effectiveness.

APPENDIX

Tentative Workshop Schedule

SIGMA – Math Achievement Center
College of the Canyons, Bonelli 207
Workshop Schedule Fall 2009
Weeks 2, 3, and 4

Fractions

Monday, August 31	3:00
Tuesday, September 1	6:00
Wednesday, September 2	1:00
Tuesday, September 8	1:00
Wednesday, September 9	6:00
Thursday, September 10	3:00
Monday, September 14	3:00
Tuesday, September 15	6:00
Wednesday, September 16	1:00

Word Problems

Monday, August 31	1:00
Tuesday, September 1	3:00
Wednesday, September 2	6:00
Tuesday, September 8	6:00
Wednesday, September 9	3:00
Thursday, September 10	1:00
Monday, September 14	1:00
Tuesday, September 15	3:00
Wednesday, September 16	6:00
Thursday, September 17	3:00
Thursday, September 17	6:00

Graphing

Tuesday, September 8	3:00
Wednesday, September 9	1:00
Thursday, September 10	6:00
Monday, September 14	6:00
Tuesday, September 15	1:00
Wednesday, September 16	3:00
Thursday, September 17	1:00

Syllabus Statements and Policies

Instructions for Syllabus Statement
COC Math 060 Supplemental Instruction Pilot – Fall 2009

Thank you for volunteering to require your students to participate in supplemental instruction either as a percentage of their grade or to improve an exam(s) score. Below are sample syllabus statements.

Supplemental Instruction Requirement:
You are required to complete 5 activities, approximately one hour each, in SIGMA - Math Achievement Center. These activities are designed to prepare you for and reinforce the concepts covered in this course. These activities represent X% [←To be entered by instructor. $5 \leq X \leq 10$] of your class grade.

The activities may include:

- Workshops: Interactive mini presentations on key topics related to this course.
- Guided Learning Activities: Independent activities including a one-on-one review and discussion.

The activities will be completed in SIGMA – Math Achievement Center in Bonelli-207. To gain access to SIGMA, please enter through the TLC in Bonelli-209. You will need to take your student ID card (not just the number) or any Photo ID to be logged into the system at the front counter.

To receive credit you must actively participate and understand the concepts being covered. Your worksheet or quiz will be collected at the end of the workshop and will be returned to me.

*[** other customized items such as regular due dates of activities or specific activities to be completed**]*

Other Important Notes:

1. You may not complete more than two activities per day.
2. All activities must be completed by Wednesday, December 9.
3. You may need to make an appointment in advance to participate in an activity so plan ahead.

Supplemental Instruction to Improve Chapter Exam Scores:
You will be allowed to retake X [←To be entered by instructor. The department recommends $X = 1$ or $X = 2$] chapter exams. [Insert a statement about which chapter exams the students may retake. See optional content notes on the next page.] After successfully completing a workshop(s) or guided learning activity approved by the instructor, you will be allowed to retake the exam (a different version). [Insert a statement about how the retake will count toward the student's grade. The department recommends that the two test scores be averaged. Please contact the course coordinator if you have questions.]

[In this scenario, instructors will not drop the lowest chapter exam nor have the final replace the lowest chapter exam. Instructors should consider their policy for missed exams. Instructors should try to return the exams at the next class meeting. Instructors should keep the retake since various students may be retaking the exam at different times.]

OPTIONAL CONTENT

1. Timeline/Due Dates
    a. Indicate the specific timeline or due dates by which students must complete their supplemental learning activities or retake their exams. The department suggests students complete their retake within two to three weeks of the exam being returned.
    b. We don't suggest letting the students wait until the end of the semester. Students will not have time to retake an exam that is given the week before final exams. Therefore the last possible exam that they should be allowed to retake is the one with rational expression/equations (chapter 8 within the Math 060 textbook).
    c. Also, the purpose of the supplemental learning is to help the students pass the class, and if they wait until the end they've missed the point.

2. Sequence of and specific activities to be completed.
    a. You have a lot of flexibility as the instructor. You may choose to indicate which activities your students do, which type of activities they work on or even the order they attempt them.
        i. For example you might require 2 workshops and 3 guided learning activities. Or maybe at least 1 workshop, 1 study group and 1 guided learning activity. The other 2 are their choice.
        ii. You might require the whole class to complete a specific topic activity.
        iii. Perhaps you won't accept any workshops on fractions.
    b. You will be provided with a list of workshops throughout the semester. Guided learning activities will be available to the students as an alternative activity should the student not be able to attend a workshop.

Sample Outline

SUPPLEMENTAL INSTRUCTION ACTIVITY

TOPIC: Graphing a line in the rectangular coordinate system
APPLICABLE COURSES: Math 058, 060, 070, 103, 104, and chemistry
TIME NEEDED: 60 minutes

LEARNING OUTCOME: (What will students be able to do by the end of the workshop?)
Students will be able to graph a line involving two variables.

CONTENT: (What do students need to know to accomplish the outcome?)

1. Vocabulary terms: slope, x-intercept, y-intercept, x-coordinate, y-coordinate, x-axis, y-axis, independent variable, dependent variable

2. Background knowledge and skills: plotting points, the letter m designates slope which represents the change in y divided by the change in x (confusion may exist between how to count spaces on a grid to plot a point and how to count spaces on a grid to represent the slope)

3. Graph lines given various forms of an equation or other information.

    a. Standard form: $Ax + By = C$

        i. practice graphing using a chart to find points on the line by plugging in values for x and values for y (have students try zero for the values)

        ii. practice graphing by finding the x-intercept and the y-intercept

    b. Slope-Intercept form: $y = mx + b$, including examples where $b = 0$.

        i. practice graphing using a chart to find points on the line by plugging in values for x (have students include the value of zero)

        ii. practice graphing using the y-intercept and the slope

METHOD: (How will the instructor deliver content? Short lecture, handouts, Powerpoint, other audio-visual presentation)
(10 minutes) Two mini lectures/examples each followed by sample problems within a worksheet.

ACTIVE LEARNING STRATEGIES: (How will students apply their knowledge? Solve a problem, create a project, analyze a case, explain a process)
(30 minutes) Two fifteen-minute practice sessions. Students will graph lines given in different forms. They will need to label several solutions to the equation. They will need to identify x-intercepts, y-intercepts, and values of slopes in different cases. Students could work individually or in pairs. Students could show mastery by writing out solutions on the board. The concept of think, pair, share would work here.

ASSESSMENT METHOD: (How will the instructor know that the students met the outcome? Check for understanding.)
(10 minutes) Students need to complete a quiz where they are asked to graph lines in different forms as well as identifying x-intercepts and y-intercepts when asked.
If students do not successfully complete the quiz, they may be asked to repeat this workshop, to seek individual tutoring, or to complete a guided learning activity.

SELF-REFLECTION ACTIVITY: (What will the instructor do to get students to reflect on how they learned the content? What they learned, how they learned it, how they will apply it in their coursework)
(5-10 minutes) Facilitators may select from the following questions.
What was the most helpful aspect of the workshop?
What questions do you still have?
With what do you need more practice? (intercepts, slope, etc.)
What two things do you need to remember when graphing on your next test?
Describe the process of graphing an equation of a line.

Sample Workshop Materials

Applications of Algebra (a.k.a. "Word Problems")

If you are like most students, the thought of solving a "word problem" in a math class makes you nervous. This is understandable for several reasons. First of all, solving a problem *is* more difficult than simply solving an equation because first you have to read and interpret the problem, *then* write down an equation and *then* solve the equation. So there are more steps and more complexities to solving word problems. Another difficulty is that in a typical algebra class we spend most of our time simplifying expressions and solving equations. Often we don't spend very much time on word problems so students don't get enough practice to become comfortable with them. *But if you ever have to use mathematics in the "real world" (i.e. outside of a classroom) you will be solving "word problems".* Almost never does anyone simply have to solve an equation. In fact, once you have an equation, a computer or calculator can usually solve it in an instant. What we humans still have to do is take various facts and information from the real-world situation, decide what is relevant and what is not, and then use algebra or other mathematical tools to solve the problem. In short, you will be solving "word problems". *If you can't solve word problems, you won't be able to put all those hours you have spent in math classes over the years to good use.*

But the most important thing to know about solving word problems is: It's OK to feel nervous! Often students don't feel comfortable solving a problem because they aren't sure how to start and they think it should be "easy" if they knew the "correct" method for solving it. But solving a real problem in never easy—if it were easy it wouldn't be a problem. The important thing to understand is that the "nervousness" you may feel can be turned into the adrenaline and excitement you need to conquer the challenge. Let me give you an analogy: Many or most people are afraid of speaking in public to a large group. They usually feel very nervous, sweaty, have "butterflies in the stomach", etc. However, there are some people who actually love to give speeches. But guess what? These "natural" speakers also get nervous, sweaty, have "butterflies in the stomach", etc. *The difference is that they consider this excitement to be a natural high and use the extra energy and concentration to do their best.* Think about actors, musicians, salespeople, surgeons, and even math teachers—many of them feel nervous before they "go on stage" but they use the extra energy to perform at their best. And people who like math, puzzles, or solving any kind of problem feel a kind of "nervous excitement" any time they are faced with a mental challenge. *So it's OK to feel nervous when you are trying to solve a problem. Use the energy to focus your mind.*

So how do we go about actually solving the problem? There isn't any one procedure which will solve all problems (if there were such a procedure they wouldn't be problems, would they?) But there are certain techniques which can be used effectively most of the time. Here are some of the most useful ones:

Study the Problem. Too often, students read through the problem (usually in paragraph form) quickly like they were reading a novel and then sit there holding a pencil and staring at a blank paper wondering what they should do next. To prevent this from happening to you, you should first read the problem several times slowly until you clearly understand the situation. It may help to restate the problem in your own words and to write down the important facts or draw a diagram showing the relevant information.

Memorize the facts: You need to study the problem carefully until you have just about memorized the facts. (In the real world you will need to become very familiar with the situation before you can start applying mathematical tools.) *If you don't understand the situation, algebra won't help you solve the problem.*

Diagram, picture, table, graph: Reading a paragraph over and over tends to be a mind-numbing experience. *The human brain has very powerful visual processors—use them.* Depending on the type of problem, you should try to draw a diagram (very useful for motion problems), draw a picture (to help you visualize the situation), put the information into a table (many instructors and textbooks emphasize this) or draw a graph.
Too much or too little information: Most problems in algebra textbooks have exactly the right amount of information. But sometimes there is unnecessary information (if you are figuring out the sales tax on a car, does it matter what horsepower of the car is?) or too little information (in which case you can't solve the problem). *In the real world we always have to decide what information is necessary and sufficient to solve the problem*.

Estimate your answer: After studying the problem, you should be able to estimate the correct answer. Don't be afraid to use your common sense (The sales tax on a $500 TV might be $40 but it couldn't be 40 cents or $400; a jet plane might fly across the country in 5 hours but not in 5 minutes). *Be sure to include the correct units for your estimate.* (Feet or inches? Centimeters or square centimeters? Minutes or hours?).

Write the Equation(s): Now we are ready for the key step: actually writing the equation or equations we will use to solve the problem. The first thing we have to do is:

Choose the variables. You don't have to always use the letters *x* and *y* for variables. Try to choose letters which will help you remember what the variable stands for:

Let D be <u>D</u>avid's age
Let s be the <u>s</u>maller of the two number
Let t be the <u>t</u>ime it takes for the second car to pass the first car

It is often OK to start with two or more variables:

The sum of two numbers is 20 so $x + y = 20$

Remember, if you have two or three variables, you will need the same number of equations to solve the problem.

Dimensional analysis: This is a fancy term for having the correct units. Looking at the units may

help us write the equation or check to see if the equation makes sense. (Remember that the word "per" is represented by division.) For example:
(miles/hour)(hours) => miles. (dollars/unit)(units/person) => (dollars/person). A basic rule is this: *We can multiply or divide quantities with different units but we can only add or subtract if quantities have the same units.* (Don't add feet plus inches—convert everything to feet or to inches first). *The units on both sides of an equation must agree*.

What is equal to what? If we are trying to write an equation (and this is the main goal of algebra problems) we need to find two things that are equal. So ask yourself the question "What is equal to what?". Are the distances equal? Are the times equal? Is the total amount of salt before the water was added equal to the total amount of salt after? *After you have determined "What is equal to what" you can write your equation.*

Try a simpler version: If you are having trouble coming up with an equation to solve, try a simpler version of the problem and use your common sense to solve it. Then ask "How did I do that?" For example *"Joe drove 486 miles and used 25.6 gallons of gas. How many miles per gallon did he get?"* If you are not sure whether to multiply or divide, try an easier version: "*He drove 80 miles and used 4 gallons*." That's 20 miles for each gallon or 20 miles per gallon. So we must have divided 80/4 = 20. For the first problem it must be 486/25.6=18.9843... which we will round off to 19.0 miles per gallon. (See "significant digits" below for the reason we round the answer.)

Solve your equation(s): This usually is the easiest part since we spend so much time in an algebra class solving equations. Note that if you used two (or three) variables you need to have two (or three) equations and you will need to substitute or use elimination to solve them. Another thing to watch out for is *extraneous solutions*. Sometimes solving our equation will give us solutions (e.g. negative) which can't possibly be solutions to the problem.

Check: You should check your solution both in the equation you wrote (in case of algebra mistakes) and also with the situation in the original problem. Re-read the problem and compare with your estimate to see if the solution is *reasonable*. Do you have the correct units? In the real world this is critical—a few years ago a spacecraft going to Mars crashed because some of the engineers were using meters and some were using feet (and these are rocket scientists)!

Significant digits: You should round off your answer if necessary to give the correct number of significant digits. For example: *Mary is going to go on a 0.8 mile hike. She knows that she can walk at 3.5 miles per hour. How long will it take Mary to get to the end of the trail?* We can solve by dividing (since $rt = d$, $t = d/r$):
(0.8 miles)/(3.5 mph)= .2285714286 hours or 13.71428571 minutes. What is wrong with this answer? Can we really predict that it will take exactly 13.71428571 minutes? Is the accuracy really better than a millionth of a second? Of course not. So we should round the answer to <u>14 minutes</u>. *We usually round off the answer to the smallest number of significant digits in the inputs to the problem.* (In a math class we sometimes use "exact" answers but in science, technology and the real world we always round off answers to avoid misleading levels of precision.)

Checklist for Solving Word Problems	YES	NO
Do you feel nervous? Is this OK?		
Have you studied the problem until you fully understand the situation? Have you memorized the facts?		
Have you drawn a diagram or a picture or made a table or a graph to help you understand the situation?		
Have you checked for too much or too little information?		
Have you estimated your answer (including the correct units)?		
Have you chosen appropriate variable(s) for the problem?		
Can you answer the question "What is equal to what?"		
Can you think of a simpler version of the problem?		
Have you checked the units involved in the problems (dimensional analysis)?		
Can you write the equation(s) to solve the problem?		
Can you solve your equation(s) and check for extraneous solutions?		
Check: Did you Re-read the problem? Compare your answer with your estimate? Check for the correct units? Round off (if the answer is a decimal)?		

College of the Canyons Mathematics Supplement

Adding and Subtracting Fractions

$\frac{2}{7} + \frac{3}{7} = \frac{5}{7}$ Why? Why is it not $\frac{5}{14}$? Isn't $2 \text{ ft} + 3 \text{ ft} = 5 \text{ ft}$? $\$2 + \$3 = \$5$?

In the case of $2 \text{ ft} + 3 \text{ ft} = 5 \text{ ft}$; 2, 3, and 5 are counting, numerating, and ft names the type of thing that is being counted, the denomination. In the case of $\$2 + \$3 = \$5$; 2, 3, and 5 are counting again, and \$ is the denomination. In both cases the denomination does not change through the addition. $\text{Ft} + \text{ft} = \text{ft}$, and $\$ + \$ = \$$. In fractions the top number is counting, i.e. numerating; so it is called the numerator; and the bottom number is identifying the type of piece that is being counted, i.e. denominating—literally, naming—so it is called the denominator. As with the ft and \$ examples above, $2 \text{ sevenths} + 3 \text{ sevenths} = 5 \text{ sevenths}$, i.e.

$$\frac{2}{7} + \frac{3}{7} = \frac{5}{7}.$$

Now try adding 3 dimes to 2 quarters. $2 \text{ quarters} + 3 \text{ dimes} =$ what? You could say it is 5 coins, or you can say it is 80 cents. Either way, you have changed the denomination to a common denomination. $2 \text{ quarters} + 3 \text{ dimes} = 2 \text{ coins} + 3 \text{ coins} = 5 \text{ coins}$, or $2 \text{ quarters} + 3 \text{ dimes} = 50 \text{ cents} + 30 \text{ cents} = 80 \text{ cents}$. Subtraction is similar.

$2 \text{ quarters} - 3 \text{ dimes}$, taking three of one thing from two of another thing, makes no sense, but if someone exchanges your two quarters for the monetary equivalent, five dimes, the problem becomes $5 \text{ dimes} - 3 \text{ dimes} = 2 \text{ dimes}$. Again, the denomination was changed to something that does make sense.

If you have a fraction that has a denominator that you do not want you can change that denominator to any multiple of itself without changing the number that the fraction represents. You just multiply both the numerator and denominator by the same number which amounts to multiplying the fraction by one, and multiplication by one does not change a number. For example, suppose you had the fraction $\frac{1}{4}$, but you preferred a denominator of 8. Just multiply $\frac{1}{4}$ by 1 in the form of $\frac{2}{2}$.

$$\frac{1}{4} = \frac{1}{4} \times 1 = \frac{1}{4} \times \frac{2}{2} = \frac{2}{8}$$