SELECTIONS FROM QUANTITATIVE REASONING SELF-ASSESSMENT

The purposes of the UA/QR Self-Assessment

- To help students and their advisors select instructional activities (such as Level 1 QR-Intensive courses and/or Math Lab tutoring) that will prepare students for work on the Level 2 QR competency
- To provide a broad overview, not a detailed picture, of students' current basic math skills strengths and areas for further learning (in the context of QR)
- To introduce students to an important and difficult learning/study skill—*self-assessment* (and, therefore, to provide a broad overview of students' current self-assessment strengths and areas for further learning)
- To begin the long process of changing the (student and faculty) culture about the importance of QR in understanding all areas of study at CPCS
- To begin the long process of changing the (student and faculty) culture about what math is—what we are calling QR
- To begin the long process of changing the messages many students (and some faculty) have internalized that they cannot "do math"

Suggested Workshop/Lesson Ideas for UA/QR Self-Assessment

Some Important Learning Experiences for Students to have before Working on the UA/QR Self-Assessment

- There is always some correct reasoning in any thoughtful solution to a problem
- There is always something you can understand about a particular problem, even if most of it is confusing to you
- There can be many equally correct ways to solve a given problem
- You are **not** "stupid" if you do not know how to solve a particular problem
- The importance of quantitative reasoning in understanding public and community service issues

Some Ideas to Provide These Learning Experiences

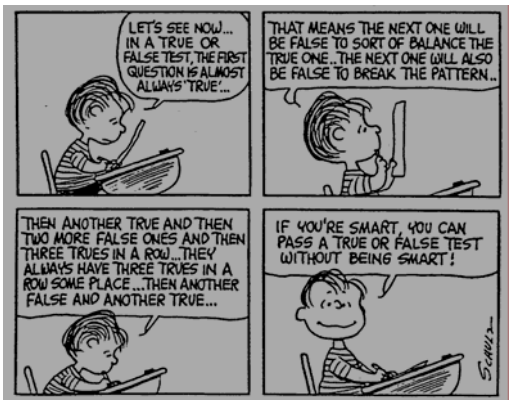
- The workshop/lesson can start with students (first in small groups, then with the entire group) discussing the following situation.. The Demara sheep herder problem can be used to illustrate that there is always some correct reasoning in others' logic, and to encourage students to respect their own logics, as well as others'. It also can illustrate that there is always something you can understand about a particular problem, even if most of it is confusing to you. The Demara problem has the additional plus of introducing cross-cultural/anti-racism politics of knowledge issues.

  The Demara problem: Ascher and Ascher (in "Ethnomathematics," *History of Science*, 1986) discuss a well-known anecdote about a trade between an African sheep herder and an explorer. The herder agrees to accept two sticks of tobacco for one sheep but becomes confused and upset when given four sticks of tobacco for two sheep. The story was originally told to show that the herder cannot comprehend that 2 + 2 = 4. Can you think of another explanation for the herder's actions?

- Then, still in the group workshop/class setting, the entire group can work on stage/part 1 of the UA/QR self-assessment. The group as a whole can help assess each other, and some students may decide at that point that they need to register for Level 1 Understanding Arguments and/or schedule regular Math Lab appointments. They should then complete the "Self-Reflections and Self-Recommendations" summary sheet. This is the only work they are required to turn in, but we can encourage them to hand in their other work to help us learn about the self-assessment process. Other students will decide to work on the next stage problem before completing their summary self-reflection and recommendation. Throughout this part of the lesson, we can emphasize again what self-assessment is, and that you are not stupid if you do not know how to solve a particular problem. In addition, this exercise provides opportunities to show different, eqaully correct methods for solving problems. It also illustrates the use of quantitative reasoning in understanding the public and community service issue of high school dropout rates among students of color.
- At this point, you may want to hand out the 3-page overview packet that reiterates the important points about the philosophy and process of the UA/QR Self-Assessment.
- Students can then work on stages 2 and 3 in either in small groups, or individually, with the students free to consult and discuss their work. At the end stage 2, students can decide again whether to complete the summary self-reflection and self-recommendation, or work on the stage 3 problem.

If at the end of their Stage 3 self-assessment, students are very comfortable with all the problems, then we can give them the UA/QR Diagnostic to complete at home. This will be reviewed by CPCS faculty to recommend whether QR at Level 2 can be demonstrated by prior learning, or if a class or other instructional activity is needed. [Note: For registration purposes, we will distribute the in-school self-assessments to the appropriate

Student Introduction to UA/QR Self-Assessment Packet



We are all "smart." The question is *how* we use our "smarts." We can use them as Charlie Brown does above, to "get over" or we can use them to study—to understand, re-create, analyze, and create—and to act to produce more justice in our world.

Part of the struggle for justice involves self-assessment, or, in other words, self-reflection about your knowledge. ***Being 'smart' is not already knowing everything, but rather a process that includes knowing what you already understand, and knowing what questions you need answered in order to understand more deeply.***

And part of the struggle to change the world involves quantitative reasoning.

The Quantitative Reasoning Self-Assessment exercises represent an overview of QR. You are **not** expected to be able to solve these problems ***NOW***. These are the kinds of problems you will be able to solve when you complete the QR competency at Level 2 in the curriculum.

But you are expected to try each problem and identify, as precisely as you can, everything about it you understand and where you get stuck. And you are expected to think about what parts of the problem are hard or easy for you, and other aspects of your study process. The answers contain suggested solutions and/or hints and explanatory notes to guide your self-reflections.

QR Self-Assessment Problems

------ PART 1

Read the following excerpt from a *Boston Globe* article.

- What do you understand about this article?
- What do you understand about what the numbers mean in this article?
- How could you compare the situation in Massachusetts with the situation in the Santa Monica-Malibu district?
- Which group of young people in Massachusetts have the worst dropout rate?
- What other information might you want to know as you think about the issue of students not completing high school?

An Elementary Lesson: It's Community that Keeps Students in School by Heather B. Weiss and M. Elena Lopez (*Boston Globe*, 9/10/2000)

These are perilous times for minority [sic] high school students. An estimated one-third of Hispanic young people in Massachusetts' Class of 2002 will not receive their high school diplomas, while a quarter of Massachusetts African-American students will not finish high school. More than 1 in 10 Asian-American students will drop out before graduating.

In all probability, a flurry of school-centered solutions will be offered to address these alarming statistics. Yet our minority [sic] children will continue to drop out if one very important factor is not addressed, and soon: the involvement of home and community in education.

[For example,] while graduation rates among high schoolers in the Santa Monica-Malibu (Calif.) Unified School District were above the national average, minority [sic] students, particularly Latinos and African-Americans, were falling behind and dropping out in record numbers.

Under a new superintendent interested in family-school-community partnerships, the district initiated a three-year leadership development program for 75 minority [sic] families, secured financing for a Community Liaison Office to foster minority engagement in school activity, and secured partnerships with community leaders and businesses to strengthen ties with schools. UCLA hosted a series of meetings in which parents, teachers, and community members discussed ideas for school reform, as well as issues of race and class.

As a result, the Santa Monica-Malibu district has overwhelmingly won the public's trust, passed three important ballot initiatives to increase school revenue with more than 70 percent approval, and reduced from 10 percent to 1 percent the dropout rate among minority [sic] students. The district's grade-point average has risen overall, as has the number of minority [sic] students enrolled in advanced placement and higher-level algebra.

Nearly 35 years of research shows that, across grade levels, families profoundly affect student attitudes toward education. Parents who supervise their children's schoolwork and monitor their friendships, who regularly communicate with teachers, and who participate in school governance are, quite simply, more likely to have children who succeed.

Communities, too, play an essential role. Beneficial after-school programs—tutoring, volunteer work, and sports—can help students focus their energy in constructive ways, provide positive social interaction and adult role models. Likewise, meaningful work opportunities—those that build skills, promote responsibility, provide challenge, and support the exercise of leadership—make critical contributions to a young person's growth.

Before statistics worsen in Massachusetts and across the nation, bofore the divide becomes any more difficult to bridge, let us collectively reassert ourselves in an effort to stem the seemingly relentless tide of dropouts. Schools need to make minority [sic] families and communities full partners in the learning process. It is far from a simple solution, yet it may be the only one that works.

YOUR SOLUTION (before and after studying the suggested solution—write any changes or questions you make after studying the suggested solution, in a different color)
YOUR REFLECTIONS—What did you learn from working on this problem?

SUGGESTED SOLUTION—PROBLEM 1:

- Some key points about this article are that it concerns students of color who are dropping out of high school, and claims that involving families and communities will improve this situation. The numbers are used to provide evidence that the dropout rates for Massachusetts high school students of color are a serious problem, and to show the improvement in dropout rates for Santa Monica-Malibu high school students of color after programs to increase family and community involvement.
- In order to answer the "math" questions, you need to know how to rewrite numbers in different forms. In another example, how could you tell whether $5 or £4 (the English symbol for their money—read '4 pounds') is greater without knowing the formula for how pounds and dollars are exchanged? In this example, we need to know how to rewrite the various fractions (one-third, one-quarter, the ratio 1 in 10) and the percent (1 %) in the same form, so that we can see at a glance which is the smaller dropout rate.
- Most students' prior learning in mathematics involves what José Segarra, one of our CPCS faculty, calls "naked numbers." In this case, we first need to write the English expressions and the ratio expression in "naked number" fraction form. Then, we can change the fractions to decimals by dividing the top (numerator) by the bottom (denominator) and then, multiplying by 100 and adding the % sign. After those transformations, it is clear that the Santa Monica-Malibu dropout rate is vastly smaller than any of the rates given for students of color in Massachusetts, and that within Massachusetts, Latinos had the worst dropout rate, followed by African-Americans, and then followed by Asian-Americans.
    - MA Latinos: One-third = 1/3 = 1 ÷ 3 ≈ 0.33333 ≈ 33 % {'≈' means 'approximately equal'}
    - MA African-Americans: a quarter = 1/4 = 1 ÷ 4 = 0.25 = 25%
    - MA Asian-Americans: 1 in 10 = 1/10 = 1 ÷ 10 = 0.10 = 10%
    - CA students of color: 1%

    - *List as much "naked number" prior learning as you remember.*
    - *List as many questions as you have about working with "naked numbers"*
- Quantitative reasoning involves more than manipulating "naked numbers." Mathematics is used throughout our curriculum as one way to understand more about public and community service issues, as in this case about students of color dropping out of high school.
- Many quantitative questions arise from this situation, including: How can we compare the MA situation to CA when the MA figures are for specific groups of students of color and the CA figures are for all groups of students of color combined? How can we compare the MA situation to CA when the time periods in which these rates were calculated may be different? How can we compare the MA situation to CA when we don't know if they used the same methods of determining who dropped out? Why were the dropout rates of certain groups left out (i.e., Whites, Native Americans)? Which of the given MA groups has more students who dropped out? Can you answer any of these questions from the information given in the excerpt?
- Is there other quantitative and/or non-quantitative information you would like to know in order to be able to learn more about the issue of dropout prevention?

------ PART 2

A news item in the *Boston Globe* on 2/14/95, indicated the following:

In order to dramatize the toll of domestic violence, a bell was sounded in the State House's Great Hall every 15 seconds. Each ring represented that somewhere in the USA during that time interval, another woman had been beaten.

Write a commentary on this news item that highlights the emotional and political impact of domestic violence. You may want to elaborate on the numerical data in such a way that it would ***make sense*** to as many people as possible and would capture the attention and imagination of most people.
Here are examples of what you may want to include:

- You may want to translate this data into the number of women beaten in an hour, a day, a week, or a year.
- You may want to suggest a new format such as "a bell will ring when a total of a hundred women are beaten" or when a thousand women are beaten, or when 1% of the women in the USA are beaten, or when 1% of the women in the world are beaten.
- You may want to expand on the meaning of the summarized data. For example, the data given above means that every one hour, 240 women are beaten in the USA. Does this mean 240 different women are beaten every hour?
- You may want to follow your commentary with a list of questions indicating the kinds of additional data that you feel would strengthen your commentary. For examples: How are "women" being defined here? If the definition is "adult female over18 years old," what kind of information do we have about younger women? Would it be useful to have quantitative data about domestic violence incidents committed against men by women? Against women by men? Against women by women? Against men by men? Is it important to include any comments about how data on domestic violence is collected?

YOUR SOLUTION (before and after studying the suggested solution—write any changes or questions you make after studying the suggested solution, in a different color)
YOUR REFLECTIONS—What did you learn from working on this problem?

SUGGESTED SOLUTIONS—PROBLEM 2:
Here are two ways to find out how many women are beaten in one day, using the data from the *Boston Globe* article:

- Some people would want to figure out how may seconds there are in a day, then figure out how many "15 second intervals" there are in a day
- Others may want to figure out how many women are beaten in one minute, then use that information to find out how many women are beaten in an hour, and then how many women are beaten in one day
- To find out the time interval in which 100 women are beaten, you may want to find out how many women are beaten in one minute, and then how many minutes it takes for a total of 100 women to be beaten

Here are some answer keys to check your calculations:

- There are 2,102,400 women beaten in one year
- There are about 172,800 women beaten in one month
- There are 40,320 women beaten in one week
- There are 5,760 women beaten in one day
- There are 240 women beaten in one hour
- Every 25 minutes, 100 women are beaten
- Every 4 hours and 10 minutes, 1000 women are beaten

Comments:

- Notice that you do not need to know how long the bell was ringing in order to calculate the various summaries of the data (i.e., how many women beaten in one year, in one day, and so on)—the key thing is the ratio given that for each ring (which equals each 15 sec time interval) one woman is beaten.
- Why do you think the people who designed this dramatization decided to break down the ratio into the average number of women beaten every 15 seconds? If you chose a different way to summarize the data in your commentary, can you say why your break down is a more effective way of highlighting the impact of domestic violence?
- This problem may have been difficult for you to work on because of the emotional aspects of the facts involved. Some of us believe that being aware of, and critically analyzing the distressing facts about our world is an important step in the struggle to change those distressing facts—knowledge is power, and the first step in gaining the power to change. But this does not mean it is easy to work with such sad data. On the contrary, it is a very hard thing to be able to work with such emotionally difficult data. Some people feel that quantifying a social problem distances us from the emotional issues. What do you feel about the issues of quantifying social problems, of "knowledge is power" and of the awareness of distressing data?

PART 3
Use the following table to answer the questions about UMass/Boston (UMB) faculty.

FULL TIME FACULTY POSITIONS AT UMB		
UNIT	*FY 1989*	*FY 1994*
ARTS & SCIENCE (CAS)	334	308
CPCS	59	50
EDUCATION	25	21
MANAGEMENT	52	48
NURSING	24	27

SECTION A: In order to compare the full time faculty positions at CPCS and CAS, we can perform a variety of calculations. Use the answers to the following calculations, and any other calculations you judge relevant, to write a brief statement comparing the full time faculty positions at both colleges.

- How many more full time faculty positions did CAS have than CPCS in FY 1994?
- In each of FY 1989 and FY 1994, what percent of the UMB full time faculty were from CAS, and what percent of the UMB full time faculty were from CPCS?
- Find the percent change (from FY 1989 to FY 1994) in full time faculty positions for CAS and for CPCS.

SECTION B: List two other conclusions you can draw from the information in this table.

SECTION C: List three other quantitative questions you would want to investigate to learn more about the situation of full time faculty at UMB.

YOUR SOLUTION (before and after studying the suggested solution—write any changes or questions you make after studying the suggested solution, in a different color)
YOUR REFLECTIONS—What did you learn from working on this problem?

SUGGESTED SOLUTION—PROBLEM 3:
SECTION A:

- To find out how many more one amount is than another, you use subtraction. So, there were 308 – 50 = 258 more full time faculty in CAS than in CPCS for FY 1994.

  Comments:

  - Sometimes people get confused if they do not know the meaning of one of the items in a table, even if it is not totally necessary for the solution of the particular problem. In this case, you do not need to know that FY means fiscal year, and you do not need to know what 'fiscal year' means to compare the full time faculty at both colleges. If you were investigating the budgets of each college further, you might need to know more about the meaning of 'fiscal year.'
  - You might have the wrong answer because you used numbers from FY 1989, or made some other error reading the table. An example of trying to identify your mistakes as you check these suggested solutions, in this case, would be to determine if your read the table incorrectly, or if you did not know that this comparison question is answered by subtraction.

- In order to find the percent of the total UMB full time faculty that each college has, you need to first add to find the total UMB full time faculty for FY 1989 and for FY 1994.
  334+59+25+52+24 = 494 full time UMB faculty in FY 1989
  308+50+21+48+27 = 454 full time UMB faculty in FY 1994
  Next, finding what percent a particular part is of the total, involves forming the fraction representing that part, and rewriting that fraction—first, as a decimal, and then as a percent.
  For FY 1989, CAS: 334 ÷ 494 ≈ 0.676 = 67.6% (the '≈' means 'approximately equal'). So 67.6% of the entire UMB full time faculty in FY 1989 were in CAS.
  Similarly, CPCS had 59 ÷ 494 ≈ 11.9% of the entire UMB full time faculty in FY 1989.
  In FY 1994, the figures were: CAS ≈ 67.8% and CPCS ≈ 11%

  Comments:

  - This calculation allows us to see that, although CAS lost 26 full time faculty, compared to CPCS' loss of 9 full time faculty during the same time period, the portion of the entire UMB full time faculty constituted by CAS remained almost the same, whereas CPCS' portion decreased. In other words, although CAS lost about 3 times as many full time faculty as CPCS, CAS remained almost the same in proportion to the entire full time faculty, whereas CPCS declined somewhat in proportion to the entire full time faculty. This comment is an example of one of the conclusions you can draw from this table after making these relevant calculations. Without these calculations, it would not be possible to compare the relative losses of both colleges.
  - **Do not panic** if you do not know or do not remember how to change fractions to percents, or any of the other basics—the point of this self-assessment is for you to begin the process of figuring out what you need to learn and/or relearn. Then we will help advise you how to strengthen your knowledge.

- 'Percent change' is a ratio, usually expressed as a percent, comparing the actual numerical change to the original numerical value.
  For CAS, that fraction is 26 ÷ 334 ≈ 7.8%, or the percent decrease in CAS' faculty was 7.8%, of CAS lost 7.8% of its full time faculty
  CPCS lost 9 ÷ 59 ≈ 15.3% of its full time faculty

  Comments:

  - This is another calculation that shows CPCS' loss was relatively greater than CAS'.
  - It is important to note that you ***cannot*** calculate the percent change by subtracting the percents of the entire faculty calculated in the previous solution. For example, CPCS' full time faculty did ***not*** decrease 11.9% - 11% = 0.9%; the percent decrease was 15.3%.
  - In order to calculate a percent change you must use the actual numerical data.
  - The most confusing aspect about working with percents can be understanding what they represent in terms of the situation they are describing. In other words, the formulas can be learned fairly easily—it is the meanings and the translation into the situations that take time and careful study.

SECTION B: There are many possible conclusions. For example,

- You can perform various percent calculations and reach conclusions such as that although Education only lost about half as many full time faculty as CPCS, their relative loss was even greater (CPCS lost 15.3% of its full time faculty; Education lost 4 ÷ 25 = 16% of its full time faculty)
- You can just compare the sizes of the numbers on the chart and reach conclusions such as that CAS has by far the largest number of full time faculty in UMB
- You can compare the percent changes in individual colleges with the percent change in the entire UMB faculty ([494 – 454] ÷ 494 ≈ 8.1%) and conclude that the percent of loss of full time faculty was not evenly distributed among the colleges.

SECTION C: Among the endless question that can be generated, are

- How many students did each college have in each of the fiscal years under consideration? How did the student to faculty ratios change in each college? (If, for example, CAS gained many students, and CPCS lost many students over the time period, then, even though CPCS lost proportionally more faculty than CAS, the student to faculty ratio at CPCS could be lower (i.e., fewer students per faculty). So these questions would give us additional information to make our comparisons of which college had greater losses.

- How many part time faculty does each college have? This, of course. Changes the situation regarding student to faculty ratios. However, there are other, some non-numerical, factors to be taken into account concerning the situation of full time faculty. More part time faculty help reduce the student to teacher ratios, but do not change the many other workloads, like committee work and student advising, that full time faculty do. And, of course, the conditions of work for part time faculty may be exploitative—and some of us would argue that when one group of faculty is treated unfairly, eventually all of the faculty will be treated unfairly.
- There are many quantitative questions about equity issues, from faculty salaries at the various colleges, and broken down according to various categories, such as race and gender and academic discipline.

SUMMARY SELF-REFLECTIONS AND SELF-RECOMMENDATIONS FOR FURTHER STUDY

Self-Reflections: Review your entire QR Self-Assessment packet. Write briefly about what you learned from the entire process. Also comment on your experience studying the problems—what was the hardest, what was the easiest problem, and why? What was the most interesting, what was the least interesting problem, and why? What suggestions do you have for us to improve this QR Self-Assessment packet?

Self-Recommendations:

- ☐ I felt confused while solving the problems in stage/parts θ 1, θ 2, θ 3. I remember very little, even after reviewing the suggested solutions. So, in order to prepare for QR work in the CPCS curriculum, I will register for the Understanding Arguments instructional activity at one Level 1, and study in the Math Lab at least once a week.
- ☐ I understood most of the problems in all of the stages/parts *after* studying the solutions. To reinforce that knowledge I will either register for the Understanding Arguments instructional activity at one Level 1, or study regularly in the Math Lab.
- ☐ I feel very comfortable with these kinds of quantitative reasoning problems. I will complete the QR Diagnostic this term. Those results will determine whether I will register for an instructional activity focused on the QR Level 2 competency next term, or study in the Math Lab to prepare to demonstrate the QR Level 2 competency through prior learning.
- ☐ I would like to review my self-recommendations with a CPCS advisor before registration.