Quantitative Reasoning report for Department Heads.

Definition:
Quantitative Reasoning: Students will demonstrate the ability to understand and communicate mathematical principles and to follow an extended line of formal reasoning. A student who is competent in Quantitative Reasoning is able to:

1. Read and identify mathematical information that is relevant in a problem.
2. Interpret and analyze mathematical information presented.
3. Select appropriate methods and apply them to solving problems.
4. Estimate and evaluate the validity and reasonableness of results. (Check and validate)
5. Effectively communicate quantitative concepts using standard written English and correct mathematical syntax.

Proposed Benchmark: 70% of Students will receive a C or better on math department's common final for MATH 118.[1]

Assessment:
In Fall 2011 the common mathematics department final exam was given to students taking MATH 118: Intermediate Algebra. MATH 118 is the lowest level course that meets the mathematics general education requirement and has been identified by the College as one of the *Achieving the Dream* "gatekeeper" courses. For many students it is the only credited math course that they take.

In Fall 2011, there were approximately 75 sections of MATH 118 that used the common final. A total of 2,177 students received a grade for MATH 118, and of that total 84 students received a grade of "Incomplete" either because they had not taken the common department exam or for other reasons related to individual course requirements.

The common final comes from Pearson Publishing and was created by the math department in the MyMathLab module of MyLabsPlus. It has been used at CCP since Spring 2010.

Due to the way the data is reported from Pearson to CCP, 600 students received a grade of zero (0) on the exam. There is no way to determine if the students actually scored a zero on the exam or if they did not take the test for another reason (e.g. class occurred at St. Hubert's). Because of these data issues, the inclusion of students with a zero on the final would potentially skew the results in ways to make the indicator much less usable. Therefore the analyses of the data found below will be with the 600 zero grades removed from the calculations.

Results:
The results below were provided by Prof. Webber and are based on data that was provided back to the College by Pearson Publishing. Although the correlation between final grade and course grade was strong (see 1, below), between 40% and 50% of students did not meet the basics of the standard (answering between 40% and 45% of the questions correctly). See 4, below. However, there are some concerns around both methods and data that should be considered.

[1] http://www.ccp.edu/site/about/assessment_evaluation/pdfs/Core-Competency-AssessmentPlan0927111rev.pdf

Results with Zero grades removed[2]

1. A Pearson Correlation Coefficient test showed that there was a significant (p = .05) correlation of r = 0.67 (N = 1577 students) between final grade in the class and the Pearson test score.

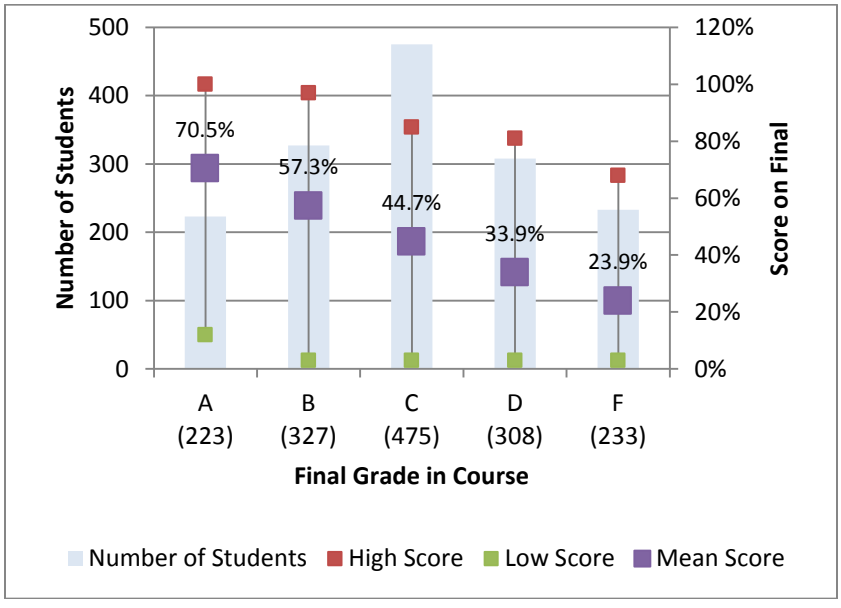
2. Using the **final grade scores** the pass rate for the 1577 students taking Math 118 was 65%. This included all students in this group with "Incomplete" grades. Deleting the students with incomplete grades had little effect on the overall pass rates (65.4%).[3]

3. The overall mean test score for this group of 1577 students was 45.72.

4. **Using a score of 45 as the passing score for the test**, **51.4% of the 2177** students passed the final test. **Using a score of 40, 58.4% of the students passed the final test**.

5. The breakdown of the data for this group of 1577 students was as follows:

Final Grade	Number of Students	Percentage of Students	Range of Test Scores	Mean Test Score
A	223	14.2%	100 to 12	70.5
B	327	20.9%	97 to 3	57.3
C	475	30.1%	85 to 3	44.7
D	308	19.5%	81 to 3	33.9
F	233	14.8%	68 to 3	23.9
I	11	0.7%	62.5 to 10	33.7



[2] For results with the zeroes included, see Appendix A.

[3] Including the students who received a grade of "Incomplete" the overall pass rate for the 2177 students taking MATH 118 is 67% and without the incomplete grades the pass rate is 69% (This includes the 600 students who received a zero on the final and were not included in the other analyses.)

There are some caveats that should be observed when examining this data.

1) It should be noted that while many students take MATH 118, there are others who place into higher level courses, about 11.5% of students who take the placement exam are slotted higher than MATH 118. (Not all students who take the placement exam enroll, and not all students who enroll take the exam, however.) If a student's completion of MATH 118 is the metric for meeting the College's standard for quantitative literacy, then students who place into higher level courses should have entered already meeting that standard.
2) Based on scoring for the MATH 118 class, some students, particularly those performing well in the class, may be deterred from performing well on the final. (I.e. they may need only a few points on the final to ensure a high grade, if they've performed well through the semester.) This has the potential to skew results, particularly if the final is used in isolation.
3) Using only students in MATH 118 may provide for some skewing of the data as the highest performing students on placement exams will be more likely to take courses other than MATH 118. This may under-represent the number and percent of students who are meeting the criteria.
4) Because of the way in which data is returned to the College, it is not, at this time, possible to link individual items on the final to the specific outcomes associated with the competency, nor tie it back to individual students (to link with additional information).

Additional Indirect Evidence:

- Students have been much less successful in courses that fulfill requirements in the Mathematics learning area than in other general education areas (IR#195).[4]
- CCP students lag behind their peers in believing the College helped develop the ability to solve numerical problems (IR#191).[5]
- Solving numerical problems had the lowest benefit score (IR#204) [6]

Suggestions:

For future assessments of Quantitative Reasoning

1) Continuing to use a common final, but supplement it with additional data to develop a predictive model for grades. This requires addressing issues of student performance above (1), but might allow for a more nuanced understanding of the contribution to the class. Another possibility would be to use the placement exam with a selection of students at the end of the course, comparing their scores before and after the course.

2) Examining a more expansive set of classes and examining quantitative competence within a broader context (e.g. courses that have courses like MATH 118 as a prerequisite).[7] Using some combination of final grades, common finals (or subsets of

[4] http://www.ccp.edu/VPFIN-PL/ir/ir_reports/ir_report_195.pdf
[5] http://www.ccp.edu/VPFIN-PL/ir/ir_reports/ir_report_191.pdf
[6] http://www.ccp.edu/VPFIN-PL/ir/ir_reports/ir_report_204.pdf
[7] See Appendix B for an example.

questions), or specific assignments. The metrics would need to be identified and developed.

3) Use a rubric, either alone, or in concert with exams or assignments.[8] This might also include pushing Pearson to return standardized exam data in a more useful format or for the development of home grown common finals by content experts so that relevant data can be more easily extracted.

[8] See Appendix C for an example.

APPENDIX A

Results of Zero grades on final test (N = 600 students)

Final Grade	Number of Students	Percentage of Students
A	27	4.5%
B	32	5.3%
C	41	6.8%
D	17	2.8%
F	410	68.4%
I	73	12.2%

Results of all data combined (N = 2177)

Final Grade	Number of Students	Percentage of Students	Range of Test Scores
A	250	11.5%	100 to 0
B	359	16.5%	97 to 0
C	516	23.7%	85 to 0
D	325	15%	81 to 0
F	643	29.5%	68 to 0
I	84	3.8%	62.5 to 0

APPENDIX B

Purpose: To form a metric to assess student performance in the Quantitative Reasoning Dimension.

Overview: the metric consists of the weighted average of the point values of grades earned in courses that are identified as meeting the Quantitative Reasoning (QR) Dimension or depend on one of those courses.

Consider:

Categorize courses into four groups:

1. Fundamental QR courses: These are courses whose prerequisites include at least one course from the Fundamental category but are not already in that category.
2. Secondary QR courses: These are courses whose prerequisites include at least one course from the Fundamental category but are not already in that category.
3. Tertiary QR courses: These are courses whose prerequisites include at least one course from the Secondary category and none from the Fundamental one and are also not already in any of the first two categories.
4. Non-QR relevant courses: These are courses that do not fall into any of the other three categories.

- For each student let F, S, and T equal his or her GPA in the courses in the Fundamental, Secondary and Tertiary categories respectively.

- Additionally, let $M = (W_1*F) + (W_2*S) + (W_3*T)$ where $(W_1 + W_2 + W_3) = 1$ and $W_1 > W_2 > W_3 > 0$ be the aggregate Quantitative Reasoning metric for agreed upon values of W_1, W_2, W_3. This will produce a number measured on the same scale as the normal course GPA.

- As a recommendation $W_1 = 0.6$, $W_2 = 0.25$, and $W_3 = 0.15$ may be a fair starting point for the weights. It may be the case that W_3 may be selected to be 0. The courses that fall into the first three course categories should not be so broad that M too strongly correlates to the student's overall GPA.

B. Webber – 18 August, 2011

APPENDIX C

Quantitative Reasoning Rubric

Quantitative Reasoning Skills	Beginning	Developing	Competent	Accomplished
	Below basic understanding Beginning = greater than 30% errors in process	**Basic understanding** Developing = 20-30% errors in process	**Good understanding** Competent = 10-20% errors in process	**Accurate and complete understanding** Accomplished = less than 10% errors in process
Read and Identify mathematical information that is relevant in a problem.	The student **cannot**	The student can, **with significant errors:**	The student can, **with minimal errors:**	**The student can, without significant error:**
	Demonstrate understanding of what is being asked and required	Demonstrate understanding of what is being asked and required	Demonstrate understanding of what is being asked and required	Demonstrate understanding of what is being asked and required
	Extract relevant information needed to solve a problem	Extract relevant information needed to solve a problem	Extract relevant information needed to solve a problem	Extract relevant information needed to solve a problem; **explain if /why other information is irrelevant**
	Recognize and interpret mathematical symbols	Recognize and interpret mathematical symbols	Recognize and interpret mathematical symbols	Recognize and interpret mathematical symbols
Interpret and analyze mathematical information presented.	The student **cannot:**	The student can, **with significant errors:**	The student can, **with minimal errors:**	The student can, **without significant error:**
	Identify key topics and types of problems	Identify key topics and types of problems	Identify key topics and types of problems	Identify and describe key topics and types of problems
	Interpret relevant information from symbols, definitions, theorems and laws	Interpret relevant information from symbols, definitions, theorems and laws	Interpret relevant information from symbols, definitions, theorems and laws	Interpret relevant information from symbols, definitions, theorems and laws
	Demonstrate understanding of mathematical vocabulary	Demonstrate understanding of mathematical vocabulary	Demonstrate understanding of mathematical vocabulary	Demonstrate understanding of mathematical vocabulary

	Follow directions to construct graphs, charts and tables to represent relevant mathematical information	**Construct** graphs, charts and tables to represent relevant mathematical information	**Independently** construct graphs, charts and tables to represent relevant mathematical information	Independently construct and **interpret** graphs, charts and tables to represent relevant mathematical information and derive the optimal solution
Problem Solving Select appropriate methods and apply them to solve problems.	The student **cannot**	The student can, **with significant errors:**	The student can, **with minimal errors:**	The student can, **without significant error:**
	Go beyond the first step of a multistep problem	Follow **an extended line** of formal reasoning	Follow **an extended line** of formal reasoning	Follow **and articulate** an extended line of formal reasoning
	Apply definitions, theorems, laws and formulas appropriately	Apply definitions, theorems, laws and formulas appropriately	Apply definitions, theorems, laws and formulas appropriately	Apply definitions, theorems, laws and formulas appropriately
	Employ technology to complement "by hand" calculations	Employ technology to complement "by hand" calculations	Employ technology to complement "by hand" calculations	Employ **and explain the use of** technology to complement "by hand" calculations
	Present an answer in an understandable form	Present a final answer in a correct	Present a final answer in a correct	Present **and explain** a final answer in correct form
Check and validate Estimate and evaluate the validity and reasonableness of results.	The student **cannot:**	The student can, **with significant errors:**	The student can, **with minimal or no errors:**	The student can **accurately and completely:**
	Check and verify that the final answer makes mathematical sense	Check and verify that the final answer makes mathematical sense	Check and verify that the final answer makes mathematical sense	Check and verify that the final answer makes mathematical sense
	Check and verify that the final answer makes common sense	Check and verify that the final answer makes common sense	Check and verify that the final answer makes common sense	Check and verify that the final answer makes common sense
	Employ technology to validate answers, as appropriate	Employ technology to validate answers, as appropriate	Employ technology to validate answers, as appropriate	Employ technology to validate answers, as appropriate
Communicate: Effectively communicate quantitative concepts using standard written English and correct mathematical syntax	The student **cannot:**	The student can, **with significant errors:**	The student can, **with minimal or no errors:**	The student can:
	Present and articulate basic concepts and results in a logical and comprehensible manner	Present and articulate basic concepts and results in a logical and comprehensible manner	Present and articulate **a variety of** complex concepts and results in a logical and comprehensible manner	Present and articulate **a variety** of complex concepts and results **thoroughly and accurately** in a logical and comprehensible manner

Apply mathematical principles to “real-life” situations	Apply mathematical principles to “real-life” situations	Apply mathematical principles to “real-life” situations	Apply mathematical principles **with facility** in “real life” situations