General Education Assessment: Spring 2014
Quantitative Reasoning

Introduction
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. (Read)
2. Interpret and analyze mathematical information presented. (Interpret)
3. Select appropriate methods and apply them to solving problems. (Solve)
4. Estimate and evaluate the validity and reasonableness of results. (Check)
5. Effectively communicate quantitative concepts using standard written English and correct mathematical syntax. (Comm.)

Each of the above has several constituent parts. These can be found in the rubric that was developed by the QR subcommittee of the general education work group to assist with assessment of the outcomes (Appendix A).

Methods
In Spring 2014, two students were randomly selected from each faculty member teaching a course that was deemed to have a significant quantitative component (courses decided in conjunction with Department Heads).[1] This was done in response to previous assessments that focused solely on MATH 118, the minimum course that meetings the math requirement for graduation. There was some concern among faculty that better students were being excluded from the sample, thereby creating an unfairly negative representation.

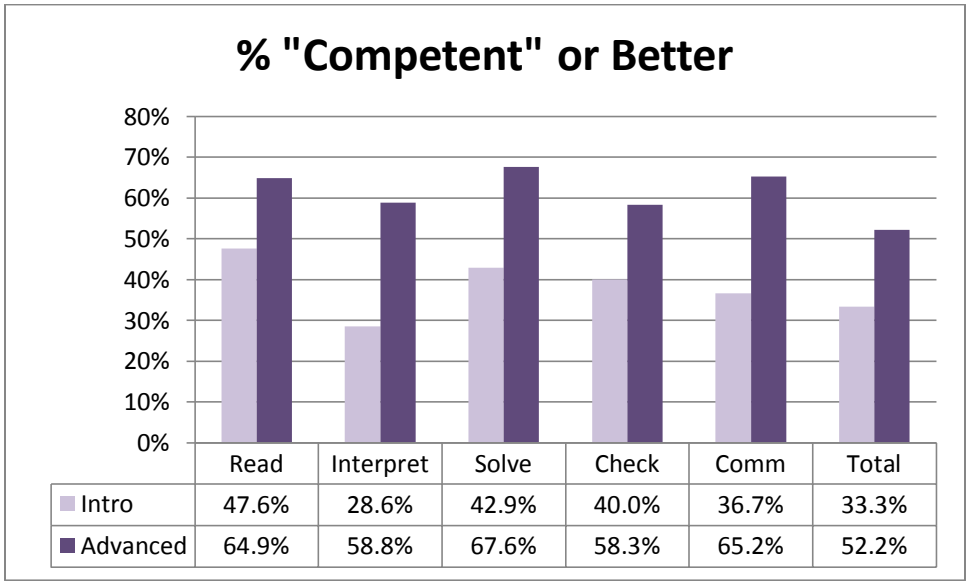
In total 195 students were selected. Emails were sent to these students informing them of their selection. Faculty received emails asking them to participate in a survey version of the rubric. Students were evaluated on a Likert Scale from 1 (Beginning) to 4 (Accomplished). There were eighty eight (88) responses, sixty one (61) of which were usable. For analysis, students were divided into two groups: those enrolled in courses with no math pre-requisites (e.g. MATH 118, ACCT 101) ["Intro"], and those with a pre-requisite (e.g. CHEM 122, MATH 263) ["Advanced"]. Two types of comparisons were performed: the averages for students in each group and percent of students in each group who were ranked as at least Competent (3).

Results
There were important differences between students in the introductory courses and those in the more advanced courses. Less than half the students were assessed as competent by faculty in the beginning courses; more than half were deemed so in more advanced classes. (Figure 1) Students in more advanced courses also had higher average scores (Figure 2), although no outcome in either group had an average of at least 3 (competent).

Some of these higher scores may simply be a result of persistence—the worst students are unable to qualify for higher level courses leaving a more mathematically inclined student population in the second group. That said, it is clear that these introductory courses may not be enough to impart the level of quantitative competence hoped for by the institution.

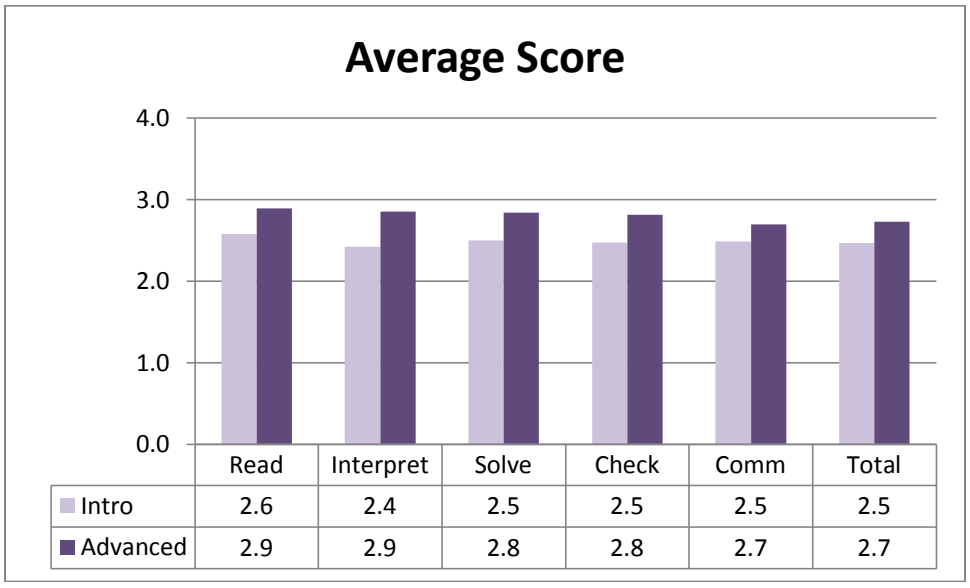
[1] ACCT 101, ACCT 102, ACCT 215, CHEM 121, CHEM 122, CHEM 222, MATH 118, MATH 150, MATH 151, MATH 161, MATH 162, MATH 163, MATH 171, MATH 251, MATH 263, MATH 272, PHYS 111, PHYS 140, PHYS 241, PSYC 167, PSYC 210

Figure 1. Percent of Students ranked “Competent” (3) or Higher



	Read	Interpret	Solve	Check	Comm	Total
Intro	47.6%	28.6%	42.9%	40.0%	36.7%	33.3%
Advanced	64.9%	58.8%	67.6%	58.3%	65.2%	52.2%

Figure 2. Average Score on each SLO



	Read	Interpret	Solve	Check	Comm	Total
Intro	2.6	2.4	2.5	2.5	2.5	2.5
Advanced	2.9	2.9	2.8	2.8	2.7	2.7

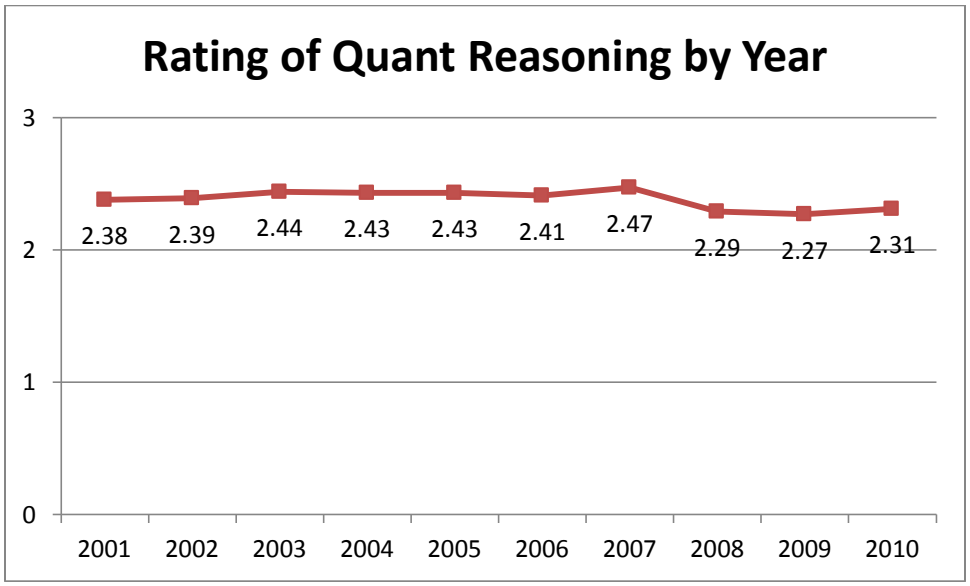
Prior Assessments

In Fall 2011 the common mathematics department final exam was given to students taking MATH 118: Intermediate Algebra. Seventy-five sections of MATH 118 used the common final (yielding 2,093 student completions). In the classes examined, 51% of students passed the common exam with a score of 45 (out of 100); and 65% of students passed the class overall. This failed to meet the proposed benchmark of a 70% pass rate (C or better) for the final.

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).[2]
- CCP students lag behind their peers in believing the College helped develop the ability to solve numerical problems (IR#191).[3]
- Solving numerical problems had the lowest (self rated) benefit score from entrance to graduation (IR#204).[4] This number has remained fairly constant in the years between 2001 and 2010 (Figure 3) (IR#225).[5]
- An analysis of the 2010 cohort of students taking MATH 118 found that 63% of students passed the course, an additional 12% passed on subsequent attempts. (In-Brief #194)[6]

Figure 3: Graduates' Self-Reported Gains in Quantitative Reasoning*



*3=Considerable Progress, 2=Some Progress, 1=Little Progress, 0=No Progress

Conclusions and Recommendations

- Current introductory courses appear insufficient to help students achieve competence. Although students struggle with passing this course, it may not be advanced enough for students to master the SLOs associated with Quantitative Reasoning.
- There is not enough evidence about student learning outcomes from departments to gauge where students are meeting related outcomes at the program and department level.

1. Students who are taking the minimum mathematics requirements are struggling to meet the minimum standards CCP has set for itself in Quantitative Reasoning. We know that many of our students do not enter ready to attempt even this level of course. This poses significant challenges as to how to raise students' to a level of basic competence. Additional required coursework, while it may promote competence would have the potential to preclude a large number of students from graduating.

[2] http://www.ccp.edu/VPFIN-PL/ir/ir_reports/ir_report_195.pdf
[3] http://www.ccp.edu/VPFIN-PL/ir/ir_reports/ir_report_191.pdf
[4] http://www.ccp.edu/VPFIN-PL/ir/ir_reports/ir_report_204.pdf
[5] http://path.ccp.edu/VPFIN-PL/ir/ir_reports/ir_report_225.pdf
[6] http://path.ccp.edu/VPFIN-PL/ir/ir_reports/inbrief_194.pdf

2. Closer examination of the requirements and whether courses are meeting the actual objectives of the general education requirements seem warranted. Although program and courses SLOs are being met in departments like Chemistry, Physics, and Accounting, students are only marginally performing on the general education requirements even in these advanced courses. Information on Mathematics's SLOs was no available. If students are meeting these and still not performing well on General Education assessments, the relationship between the two must be further explored.

3. Quantitative Reasoning should be evaluated again in two years.

Appendix A: Quantitative Reasoning Rubric

Quantitative Reasoning Rubric

Quantitative Reasoning Skills	Beginning (1) **Below basic understanding** Beginning = greater than 30% errors in process	Developing (2) **Basic understanding** Developing = 20-30% errors in process	Competent (3) **Good understanding** Competent = 10-20% errors in process	Accomplished (4) **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