GES3 Solve problems using quantitative reasoning.

MATH1010 Foundations of Math

Semester: FALL 2013

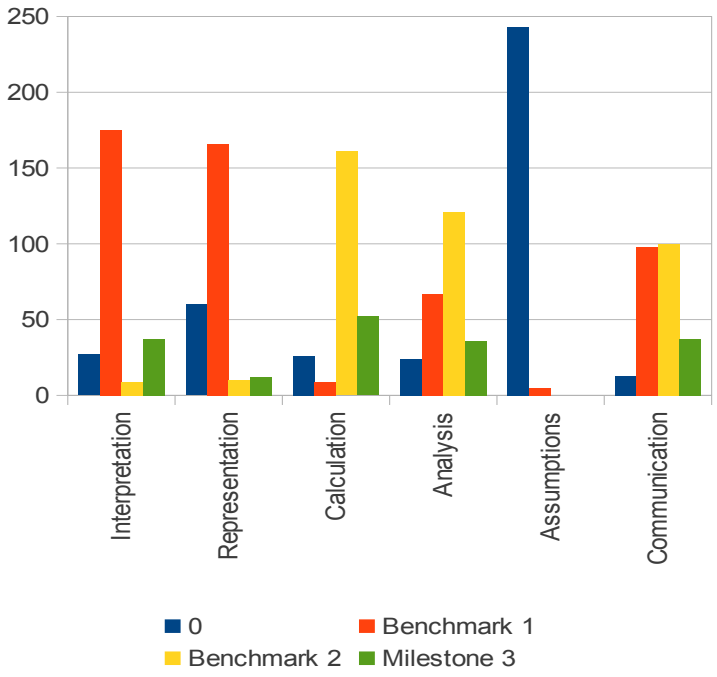
REPORT DATE: 1/13/2014

Foundations of Math is an introductory level mathematics course that serves non-stem/business majors such as liberal arts, education, or fine arts. QR assessment was composed of selected questions given on the third (and final) common exam scored by one instructor using the AAC&U Quantitative Literacy Value Rubric.

Number of students:
314 enrolled
248 completed
assessment (test 3)

Number of sections:
11 registered
11 assessed

Distribution of Scores



Mean scores overall:

Criteria	Mean
Interpretation	1.2258
Representation	0.8952
Calculation	1.9637
Analysis	1.6815
Assumptions	0.0202
Communication	1.6492

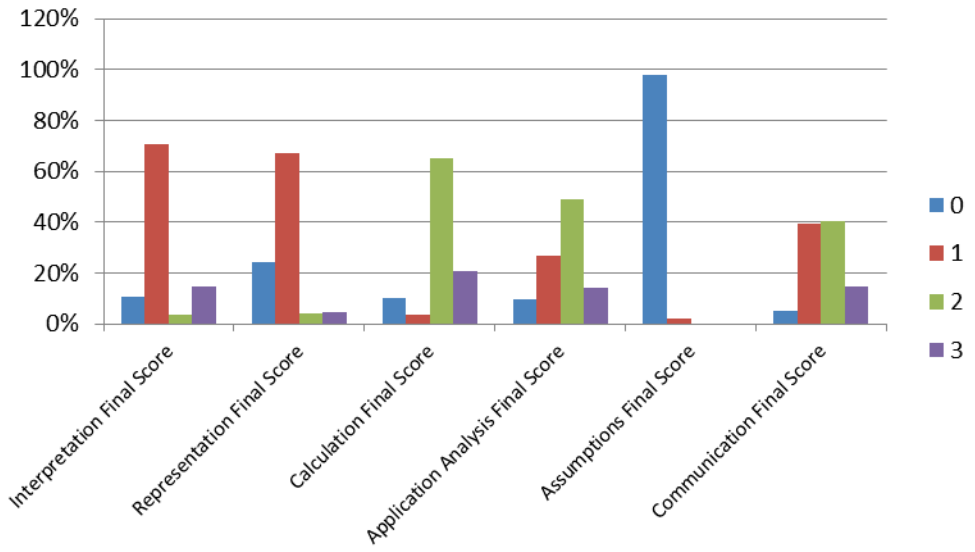
Distribution of Scores:

	Interpretation	Representation	Calculation	Analysis	Assumptions	Communication
0	27	60	26	24	243	13
Benchmark 1	175	166	9	67	5	98
Benchmark 2	9	10	161	121	0	100
Milestone 3	37	12	52	36	0	37
Total	248	248	248	248	248	248

Percentages of Score

	Interpretation Final Score	Representation Final Score	Calculation Final Score	Application Analysis Final Score	Assumptions Final Score	Communication Final Score
0*	11%	24%	10%	10%	98%	5%
1	71%	67%	4%	27%	2%	40%
2	4%	4%	65%	49%	0%	40%
3	15%	5%	21%	15%	0%	15%

**0: no response*



Discussion/Action/Closing the Loop:

Background

Math1010 is a terminal course developed for non-STEM majors (nor other programs such as business, economics, psychology, that require pre-calculus or higher level math.) Quantitative Reasoning in the context of this course we have defined as Proportional Reasoning. Our goal for our students is for them to be able to make reasonable proportional judgments within their fields of study (for example be able to compare the age of Egyptian or Chinese cultures with that of the US proportionally and have that comparison inform judgments about History, Politics, economic development, human rights, etc.) or in the context of their own economic and political lives (for example be able to judge the size of the US national debt, or compare proportionally local property tax rates to those of other states, etc.) To this end we focus Math1010 mathematical content on sets, number and numeral (especially rational numbers), linear equations, variation, geometrical (and other) formulas, percents, and probability. We then are in the process of embedding this content within realistic contexts that relate to a wide range liberal arts programs.

The Fall 2013 assessment was the first analysis of Math1010 students' learning based on the AAC&U Literacy Value Rubric applied to open-ended quantitative reasoning questions designed using data from 2 semesters of smaller pilot studies within Math1010 of proportional reasoning and open-ended problem solving.

Results Interpretation

1. Students show weakness in interpretation (15% met level 3) and representation (5% met level 3). This weakness is not surprising as students (in particular freshmen) may have had little experience with such problems and in answering such without typical categorical clues (test is on probability so interpret everything as probability etc.) Additionally, students may have had little experience explaining their thinking, conclusions, analysis[1] and must be given many more opportunities to practice these skills. To this end we must begin to revise the course curriculum and pedagogy as follows:

    - All assignments (Mathlab homework, quizzes, and tests) must be expanded/enriched with instructor designed open-ended authentic problems (at least one per assignment) that require students to go beyond calculation to explain their solution processes and reflect upon and evaluate their answers.

    - Class time must include additional practice with open-ended authentic problems and the analysis there of. To that end all quizzes will include open ended problems that will be reviewed and analyzed in class.

2. Students were successful with calculations on familiar problems but less so on problems with unfamiliar or not previously seen contexts. For example, 146 students reached Milestone 3 on a pay-cut pay raise question, while only 25 students reached Milestone 3 on the interpret the size of the National Debt question. In particular it is difficult to trigger students' multiplicative, and

1 Majority of our student may not have experienced the Common Core Curriculum throughout their secondary education as the Common Core State Standards were adopted in NJ in 2010 (http://www.state.nj.us/education/sca/).

therefore proportional thinking. Student' inappropriate use of solely additive thinking (59 students subtracted a sum of college tuition and of median income from 17.5 trillion and used that result to judge 17.5 trillion to be large) may originate from poor instruction on multiplication which defined multiplication as repeated addition instead of a unit-changing operation2 Therefore, students do not engage in multiplicative thinking in unit changing mathematical situations, rather they fall back on additive comparisons when asked to evaluate the size of a quantity. Within the topic of numbers we need to expand the curriculum to in particular explore the meaning of multiplication and the limits of additive comparison. This concept can be further reinforced and connected in the geometry, percent, and probability components of the course. Homework assignments must be expanded to underscore these connections.

3. Students were least ready to address the assumptions underlying quantitative situations. We do not address assumptions at all in most of Math1010 content. Up to this point we have been satisfied with discussion of assumptions mostly left to Statistics (Math1016). Assumptions, however, are particularly important in probability (especially in thinking about the difference between theoretical and empirical probability) and in large scale estimations (for example the size of the National Debt, US population, etc.) We need to evaluate our current curriculum to see how we can introduce, connect, and emphasize the consideration of assumptions throughout the content of Math1010.

4. Students were very willing to analyze and make judgments but often based their opinions on previous experiences and not on the quantitative information within the problems or their solutions. Again, we can begin to address this weakness by including open-ended problems throughout our curriculum and providing student with opportunities to practice throughout the course (see 1).

5. Continue to develop economical and effective means of communication and curriculum/pedagogy dispersion to our adjunct faculty to insure uniformity of learning opportunities in all sections of the course.

Other Future Considerations

1. Align our course curriculum and pedagogy with the needs of relevant programs. Initiate cross program discussion(s) of GE level quantitative reasoning and use it to improve our courses.

2. Explore developing 2 new (offshoots) GE mathematics courses:

    - Math for elementary school teachers
    - Math for fine and performing arts

3. Review entire Math1010 curriculum and use of Mathlab.

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2 http://www.maa.org/external_archive/devlin/devlin_06_08.html

Appendix – Assessment Questions

1. The current U.S. National Debt is about 17.2 trillion dollars ($17,200,000,000,000). Use some or all of the information below to make sense of the National Debt, then type your answer to the questions below:

In-State Kean University Tuition, Books, Fees, Room & Board (2012):	$ 29,515
Out-of-state Kean University Tuition, Books, Fees, Room & Board (2012):	$ 35,557
Median Price of a New Home Sold in United States (2010):	$221,800
Average Student Loan Debt for U.S. Undergraduates (2010):	$ 25,119
Median U.S. household income, (2007-2011)	$ 52,762

In your opinion, is the U.S. National Debt large or small? Can you describe how large or how small? Show any and all calculations you do below. Explain your reasoning as clearly as possible.

2. Rhena's salary is $45,000.00 a year at her first job, but unfortunately the bad economy results in all employees getting a 15% pay cut for 2011. Then in 2013 because things get better, everyone gets a 15% pay raise. Why is Rhena's 2013 salary NOT $45,000.00 like it was before the pay cut in 2011? Explain and support your explanation with appropriate calculations!

3. Consider the following two events:

Event A

You watch a news program during which a US Senator rails against wasteful government spending. Two video clips are shown of this politician. In the first he is shown giving a speech at a political fund-raiser complaining about the spending of 40 million dollars on highway improvements. In the second clip he is giving a speech at a rally where he mentions the same highway spending, but this time he says 40 billion dollars is being wasted.

Event B

You decide to grab a quick meal at a McDonald's drive-through and order 3 items from the dollar menu; small fries, a double cheeseburger, and a small coke. When you pull up to the window to pay, the cashier asks you for 3 thousand dollars instead of the 3 dollars that you were expecting. These two situations present obvious mistakes, but are these mistakes equally bad? Are they similar or different? How similar? How different? Is one situation (mistake) worse than the other? Explain as fully as possible!

4. Suppose that in Lottery A you have to choose 6 numbers from 1-69, and in Lottery B you have to choose 7 numbers from 1-55. Which lottery would you rather play and why? Justify your answer by calculating the probability (or odds) of winning in BOTH lotteries.

Quantitative Literacy VALUE Rubric

for more information, please contact value@aacu.org

Association of American Colleges and Universities

Definition

Quantitative Literacy (QL) – also known as Numeracy or Quantitative Reasoning (QR) – is a "habit of mind," competency, and comfort in working with numerical data. Individuals with strong QL skills possess the ability to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations. They understand and can create sophisticated arguments supported by quantitative evidence and they can clearly communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, etc., as appropriate).

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.

	Capstone 4	Milestones 3	2	1
Interpretation *Ability to explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words).*	Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information. *For example, accurately explain the trend data shown in a graph and make reasonable predictions regarding what the data suggest about future events.*	Provides accurate explanations of information presented in mathematical forms. *For instance, accurately explain the trend data shown in a graph.*	Provides somewhat accurate explanations of information presented in mathematical forms, but occasionally makes minor errors related to computations or units. *For instance, accurately explain trend data shown in a graph, but may miscalculate the slope of the trend line.*	Attempts to explain information presented in mathematical forms, but draws incorrect conclusions about what the information means. *For example, attempt to explain the trend data shown in a graph, but will frequently misinterpret the nature of that trend, perhaps by confusing positive and negative trends.*
Representation *Ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words).*	Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a further or deeper understanding.	Competently converts relevant information into an appropriate and desired mathematical portrayal.	Completes conversion of information but resulting mathematical portrayal is only partially appropriate or accurate.	Completes conversion of information but resulting mathematical portrayal is inappropriate or inaccurate.
Calculation	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem. Calculations are also presented elegantly (clearly, concisely, etc.)	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.	Calculations attempted are either unsuccessful or represent only a portion of the calculations required to comprehensively solve the problem.	Calculations are attempted but are both unsuccessful and are not comprehensive.
Application / Analysis *Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis.*	Uses the quantitative analysis of data as the basis for deep and thoughtful judgments, drawing insightful, carefully qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for workmanlike (without inspiration or nuance, ordinary) judgments, drawing plausible conclusions from this work.	Uses the quantitative analysis of data as the basis for tentative, basic judgments, although is hesitant or uncertain about drawing conclusions from this work.
Assumptions *Ability to make and evaluate important assumptions in estimation, modeling, and data analysis.*	Explicitly describes assumptions and provides compelling rationale for why each assumption is appropriate. Shows awareness that confidence in final conclusions is limited by the accuracy of the assumptions.	Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.	Explicitly describes assumptions.	Attempts to describe assumptions.
Communication *Expressing quantitative evidence in support of the argument or purpose of the work (in terms of what evidence is used and how it is formatted, presented, and contextualized).*	Uses quantitative information in connection with the argument or purpose of the work, presents it in an effective format, and explicates it with consistently high quality.	Uses quantitative information in connection with the argument or purpose of the work, though data may be presented in a less than completely effective format or some parts of the explication may be uneven.	Uses quantitative information, but does not effectively connect it to the argument or purpose of the work.	Presents an argument for which quantitative evidence is pertinent, but does not provide adequate explicit numerical support. (May use quasi-quantitative words such as "many," "few," "increasing," "small," and the like in place of actual quantities.)

Appendix rubric