GES3 Solve problems using quantitative reasoning.

MATH1030 Problem Solving

Semester: FALL 2013

REPORT DATE: 1/13/2014

Problem solving 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 portfolio problem evaluation scored holistically by one instructor using the AAC&U Quantitative Literacy Value Rubric.

Number of students:

27 enrolled

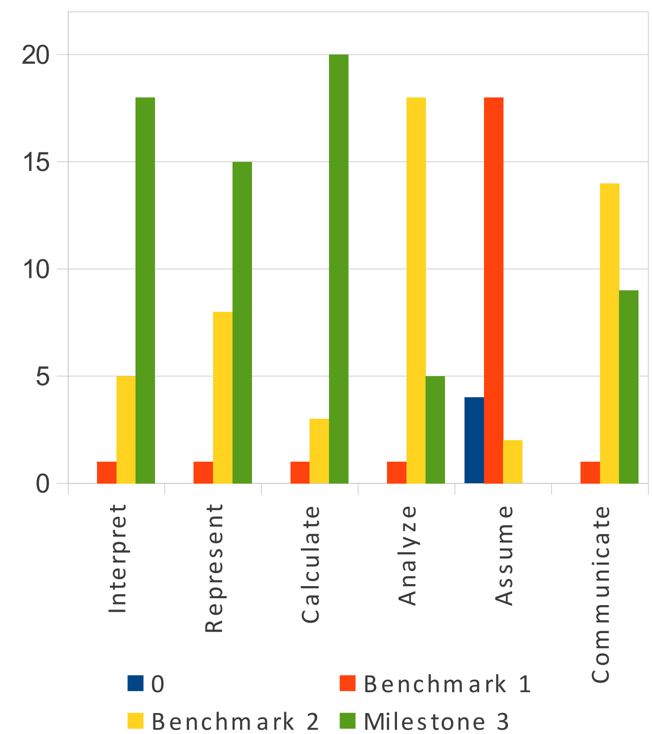
24 completed assessment (final portfolio)

Number of sections:

1 registered

1 assessed

Distribution of Scores



Mean scores overall:

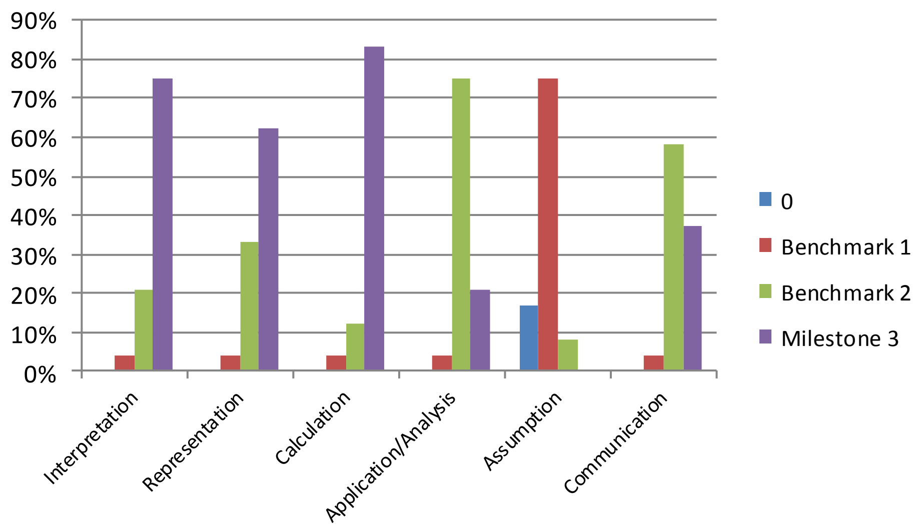
Criteria	Mean
Interpretation	2.708
Representation	2.583
Calculation	2.792
Analysis	2.167
Assumptions	0.917
Communication	2.333

Distribution of Scores:

	Interpret	Represent	Calculate	Analyze	Assume	Communicate
0	0	0	0	0	4	0
Benchmark 1	1	1	1	1	18	1
Benchmark 2	5	8	3	18	2	14
Milestone 3	18	15	20	5	0	9
Total	24	24	24	24	24	24

Percentages of score

	Interpretation	Representation	Calculation	Application/ Analysis	Assumption	Communication
0	0%	0%	0%	0%	17%	0%
Benchmark 1	4%	4%	4%	4%	75%	4%
Benchmark 2	21%	33%	13%	75%	8%	58%
Milestone 3	75%	63%	83%	21%	0%	38%



Discussion/Action/Closing the Loop:

Background

Math1030 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 has not been defined. Our goals for our students in this course are for them to become more flexible problem solvers, to develop meta-cognitive skills in analysis of their own problem solving approaches, processes, and solutions. To this end we focus in Math1030 on non-traditional problems, puzzles, problems with extraneous information, problems with missing information, logic problems, paradoxes, and some light proofs and proofs without words. The mathematical content includes algebra, number theory, logic, applications, geometry, number theory, and other varied topic that students may themselves contribute. We are in the early process of developing this course and fine-tuning the assignments. The students who take this course can have a very wide range of mathematical background, but occasionally may include Computer Science majors as well as Liberal Arts. The most complex pedagogical and content task for this course is to include enough problems on many levels so that students with very poor procedural skills as well as those with advanced mathematical knowledge can both learn and succeed, perhaps while working on problems with highly differing levels of mathematical content knowledge.

The Fall 2013 assessment was the first analysis of Math1030 students' learning based on the AAC&U Literacy Value Rubric applied to students' final portfolios[1]. We have to interpret these results with great caution as students did have the opportunity to revise their work.

Results Interpretation

1. Students' scores were much higher than those from Math1010. One explanation could be that students reviewed and revised their work and so they performed better than in a timed-testing situation. Additionally, the focus in this class was on constantly explaining, analyzing, and sharing a relatively small set of challenging problems (not exercises), so the students had a lot more practice communicating, interpreting, representing, and analyzing the problems and their solutions.

2. Students performed the best on Calculation. 83% demonstrate their calculation skills at level 3. Calculation was less emphasized (in the sense that it was not the 'end' of the solving process but rather the beginning or midpoint), but that also may have strengthened students' performance on this aspect. Also, again, students had multiple tries to get a problem 'right', so the relatively high rate of performance in calculation may not really be comparable to calculation in Math1010 or other GE math courses.

3. Students performed the lowest on assumption. No student met level 3 with 75% at level 1 and 8% at level 2. Assumptions were not explicitly discussed and therefore that low score is consistent with the course context. More thought has to be given to assumptions in problem analysis and discussions, however, students in this course did score better on the Assumption facet of the rubric than students in Math1010.

4. This course in particular offers us a great opportunity to innovate and tailor the math content to the needs and interests of the students.

5. In the Spring 2014 semester we should be able to:

- complete constructing the course (finalize a list of core existing problems) and core assignments
- develop the portfolio guidelines into a portfolio rubric that aligns well with the AAC&U Quantitative Literacy Value Rubric and the AAC&U Problem Solving Value Rubric.

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 multiple grouped sections of this course – one for Computer Science majors, the other for Liberal Arts students.

3. Apply also the Problem Solving Rubric in Math1030.

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1 See Appendix page for general portfolio requirements.

Appendix Rubric

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, saccurately 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 – Math 1030 – Portfolio Checklist

Your portfolio should include 12 to 24 problems (or more depending on length/difficulty[2]) and should follow the following guidelines:

- **You must include at least one solution using at least 10 of the following problem-solving strategies.**

Look for a pattern (algebra) ☐

Draw a diagram (picture proof/explanation) ☐

Concrete representations
(draw, take pictures of various stages of the solution) ☐
    Act it out
    Make a model
    Use a manipulative

Eliminate possibilities ☐

Guess and test ☐

Work a related problem (solve a concrete first, etc.) ☐

Work backwards ☐

Simplify and/or solve a subproblem ☐

Experiment or simulate ☐

Organize data ☐
    List systematically
    Draw a graph
    Scale a drawing

Use matix logic ☐

Change focus ☐
    Change point of view
    Solve a complementary problem
    Change representation

Other (personal inventions) ☐

2

In general *2 small problems = 1 large problem*, but many interesting solutions to one small problem can equal a big problem, or generalizing or creating variations of small problems can equal a big problem, check with me to make sure.

- **You must solve at least 5 problems in 2 or more ways (ie. Using 2 or more different strategies).**

  ☐ ☐ ☐ ☐ ☐

- **Your problem write-ups must include:**

  i. statement of the problem
  ii. solution (or two) written out in detail (err on the side of saying too much)
  iii. meta-cognitive commentary on your solution process that answers the following questions:
     a) What errors (if any) and/or difficulties did you make/have while solving the problem?
     b) What generalizations can you make about similar problems and their solutions?
     c) What method of solution is *best* for this problem? *(consider efficiency of solutions, clarity of solution process, insight generating solution, ease of generalizing the solution, ease of understanding the solution, and transfer to other problems of the solution process)*
     d) What insights into your own thinking did you develop while working on this problem?

- **Your portfolio must include a final summary:**
  Discuss and reflect on the entire course.
  - What did you learn? What did you not learn?
  - What insights about your own problem-solving thinking did you develop?
  - What insights about your own mathematical thinking did you develop?
  - What insights about mathematics (or some particular subsection of mathematics) did you develop?
  - Do you approach problems outside this class (in *real* life or other classes) differently now?
  - Do you see progress in your thinking and problem solving in your portfolio?
  - What kinds of problems did you enjoy the most? The least?
  - What problem strategies appealed to you the most? The least?
  - What problem strategies do you think you are good at? Not so good at?
  - What did you enjoy the most in class? The least?
  - What problems do you think we should eliminate from the course? What problems should we add?
  - Closing thoughts about anything.