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

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:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Interpret</th>
<th>Represent</th>
<th>Calculate</th>
<th>Analyze</th>
<th>Assume</th>
<th>Communicate</th>
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</thead>
<tbody>
<tr>
<td>Benchmark 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>Benchmark 2</td>
<td>1</td>
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<tr>
<td>Milestone 3</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>18</td>
<td>2</td>
<td>14</td>
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<td>Total</td>
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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.
## Quantitative Literacy Rubric

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- **1** indicates a basic level of understanding and skill.
- **2** indicates a competent level of understanding and skill.
- **3** indicates a proficient level of understanding and skill.
- **4** indicates an advanced level of understanding and skill.
Appendix – Math 1030 – Portfolio Checklist

Your portfolio should include 12 to 24 problems (or more depending on length/difficulty²) 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 matrix logic
  - Change focus
    - Change point of view
    - Solve a complementary problem
    - Change representation
  - Other (personal inventions)

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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.