February 10, 2015

TO: Faculty at all UH campuses
FROM: UH Mānoa Quantitative Reasoning Working Group
RE: Proposed QR implementation models and request for feedback

Proposed Quantitative Reasoning (QR) implementation models and request for feedback

Faculty at UH Mānoa want all undergraduates, regardless of major, to exit with quantitative reasoning (QR) competency and to be able to use this competency in their personal and professional lives. In addition, to remain accredited by the Western Association of Schools and Colleges (WASC), UH Mānoa must demonstrate that students have QR competency. Thus, the UH Mānoa Quantitative Reasoning Working Group (QRWG), with faculty from across the curriculum, was formed in February 2014 at the request of the Mānoa Faculty Senate Executive Committee, General Education Committee, Foundations Board, and the Vice Chancellor for Academic Affairs. Our charge is to create a way for the required undergraduate curriculum to offer students sufficient opportunities to develop quantitative reasoning (QR) skills.

The QRWG will soon propose two implementation models to the UHM Faculty Senate that are designed to provide students with quantitative reasoning instruction and experiences. Both models ask for changes to the UHM General Education Program and thus, regardless of which is selected, campus and Board of Regents approval will be needed.

- Model 1 and Model 2 replace the Foundations Symbolic Reasoning requirement with a Foundations Quantitative Reasoning requirement; and
- Model 2 replaces a Focus Writing-intensive requirement with a Focus Quantitative Reasoning requirement.

Please email your feedback and constructive comments to qrwg.hawaii@gmail.com.

A. Background

The proposed implementation models were developed after much consultation with faculty across the UH system. Consultation began in April 2014 when the Quantitative Reasoning Working Group (QRWG) introduced its work and distributed a draft definition of QR to faculty at all UH campuses via UH Announce (4/11/2014, email subject line: UH Manoa Quantitative Reasoning Working Group (QRWG)). We continued system-wide consultation in November 2014 when we distributed a modified draft definition and draft QR hallmarks via UH Announce (11/13/2014, email subject line: Feedback Requested).
In addition, the QRWG consulted in person and by email with targeted individuals and groups, including departments that offer Foundations Symbolic Reasoning (FS) and professors who teach FS, the UHM Department of Mathematics, UHM General Education Committee, UHM Foundations Committee, UHM Arts & Sciences Faculty Senate Executive Committee, UHM Deans and Directors, UH System-wide Foundations Committee, and the UH Council of Chief Academic Officers.

The feedback received has been overwhelmingly positive and constructive. We have used the feedback to modify and improve the draft QR definition and draft QR hallmarks. Over 30 faculty members took the time to email the QRWG and all groups contacted provided feedback. To date, the website has received over 1,200 visits since March 2014 (http://manoa.hawaii.edu/quantitativereasoning).

The expert sources we consulted include the following:
- Syllabi, assignments, course descriptions, including StatWay, QuantWay, Math 100, Math 132, science courses that require quantitative reasoning and financial literacy initiatives
- Association of American Colleges & Universities’ Quantitative Literacy VALUE rubric
- Common Core Math Standards, grades 9-12 Recommendations from the Mathematical Association of America
- Publications such as Health Literacy and Numeracy and Mathematics and Democracy

During our work, the QRWG has followed these principles:
- ensure that UHM undergraduates, regardless of major, have sufficient opportunities to develop QR skills
- gather and use feedback from faculty members, faculty groups, and administrators from all UH campuses;
- do not increase the overall number of required general education credits/courses and use existing mechanisms for seamless transfer so student graduation in four years/120 credits is possible; and
- address WASC accreditation requirements.

B. Proposed Implementation Models
We plan to propose the two models to the UHM Faculty Senate for its consideration. Because the models modify General Education requirements, both the UHM Faculty Senate and the Board of Regents approval will be needed.

The two proposed models share the following benefits:
- provide students with a required QR learning experience;
- do not change the number credits/courses required for graduation;
- build on the existing general education framework and philosophy;
- allow for seamless transfer;
- meet WASC accreditation requirements as well as the quantitative reasoning requirement of the Accrediting Commission for Community and Junior Colleges (which accredits UH community colleges).
Proposed Model 1. Foundations requirement and targeted emphasis

1) General description
   Students take one foundational QR course and QR is reinforced in targeted general education Diversification courses.

2) Changes to requirements and curriculum
   a) Modify the current General Education requirements as follows:
      i) add a Foundations Quantitative Reasoning (FQ) requirement (3 credits) and
      ii) remove the Foundations Symbolic Reasoning requirement (3 credits).
   
      The QR definition is in Section E and FQ hallmarks are in Section F.
   
   b) Reinforce QR in courses across the curriculum that lend themselves to QR, starting with general education Diversification Biological Science, Physical Science, Science Lab, and Social Science courses.

3) Specific benefits of Model 1
   a) Students have exposure to QR at the foundational level.
   b) Many existing FS courses address many of the FQ hallmarks (Section F) and can be converted to FQ with minor to moderate changes. In the case of an FS course needing major changes to meet the FQ hallmarks, course renumbering will have to occur if faculty want to apply for the FQ designation.
   c) Reinforcement of QR will occur in targeted courses that lend themselves to QR.
   d) Faculty across the curriculum interested in infusing QR in their courses can and will have resources available. Resources can be found on the QR website.
   e) No change to Focus requirements.

4) Challenges
   a) Faculty need to ensure that QR skills and knowledge are reinforced in non-FQ courses. Creation of a faculty group is likely needed in order to provide necessary resources.
   b) Evidence of learning can be collected from the FQ courses; however, evidence of learning from other courses will be difficult to identify and systematically collect for the purpose of program-level assessment of student learning.
   c) At the foundational level, each FQ course will have a course component with a 30-1 student to instructor ratio (or the class is limited to 30 students). Currently, MATH 100 at UHM does not meet this hallmark and faculty will need to determine an effective solution. Options include the following: Supplemental Instruction, online tutoring, graduate student assistants, recitation sections.

Proposed Model 2. Foundations requirement plus Focus requirement

1) General description
   Students take two required courses that emphasize QR.

2) Changes to requirements
   Modify the General Education requirements as follows:
   a) add a Foundations Quantitative Reasoning (FQ) requirement (3 credits);
b) remove the Foundations Symbolic Reasoning requirement (3 credits);
c) add a Quantitative Reasoning (QR) Focus requirement (1 course) that can be satisfied with a course numbered 200-499; and
d) decrease the required number of Writing-intensive courses from five to four (at least two of the four must be at the 300- or 400-level).

The QR definition is in Section E, the FQ hallmarks are in Section F, and the Focus QR hallmarks are in Section G.

3) Specific benefits of Model 2
   a) Students have exposure to QR in a foundational course and in a Focus course which will help develop their QR skills.
   b) Many existing FS courses address many of the FQ hallmarks (Section F) and can be converted to FQ with minor to moderate changes. In the case of an FS course needing major changes to meet the FQ hallmarks, course renumbering will have to occur if faculty want to apply for the FQ designation.
   c) The Focus requirement supports the goal of anchoring QR in context and encouraging QR to be practical and a habit of mind of all students regardless of academic discipline.
   d) Because UHM can collect and evaluate evidence of students’ QR skills from the foundational courses and the Focus courses for the purpose of program-level assessment of student learning, the model is conducive to meeting WASC accreditation requirements.

4) Challenges
   a) Need a very high level of faculty commitment from across the curriculum. Cooperation and effort from faculty in all undergraduate degree programs will be needed so that students have sufficient course offerings to fulfill both the Foundations and the Focus QR requirements.
      Degree programs in non-STEM fields will need to create and offer Focus QR courses. Resources can be found on the QR website.
   b) Faculty in all disciplines will need resources and assistance to enhance or add QR in their courses.
      i) A UHM working group (or equivalent) of faculty with QR knowledge is needed to make resources and assistance available to STEM and non-STEM faculty; the General Education Office is needed to oversee course designation logistics and assist the general education boards/committees.
   c) A Focus faculty board, similar to other Focus Boards, will need to be created and will need to actively oversee the Focus QR, including recruiting and assisting with ensuring sufficient Focus QR courses are offered to allow for timely student graduation.
   d) At the foundational level, each FQ course will have a course component with a 30-1 student to instructor ratio (or the class is limited to 30 students). Currently, MATH 100 at UHM does not meet this hallmark and faculty will need to determine an effective solution. Options include, but are not limited to, the following: Supplemental Instruction, online tutoring, graduate student assistants, recitation sections

C. Articulation and Fulfillment of the Requirement(s)
Quantitative reasoning requirements will be implemented over several years. We plan to have UHM start offering quantitative reasoning courses in 2016-2017 alongside Foundations Symbolic Reasoning
(FS) courses. The UHM Foundations Symbolic Reasoning (FS) courses have been approved until summer 2018 and UHM departments can continue to offer them as FS until then. In fall 2018, all entering students will be required to fulfill the new general education requirements. Starting in fall 2018, students who entered UHM prior to fall 2018 will have the option of fulfilling the current general education requirements or “moving up” to the new general education requirements with the quantitative reasoning requirement(s). In fall 2018 and later, students under the previous general education requirements will satisfy the Foundations requirement with a Foundations quantitative reasoning course.

Articulation will follow the UH established procedures. For the procedure on within-system transfer, please read Executive Policy E5.209, University of Hawai‘i System Student Transfer and Inter-campus Articulation.

In regards to a Foundations Quantitative Reasoning (FQ) requirement, students who take a course at another college/university that is equivalent to a UHM course have satisfied the UHM requirement that the UHM course satisfies (approved transfer courses are listed in the UH System Transfer Credit Database). For example, if MATH 150 at “X University” is equivalent to a Foundations Quantitative Reasoning (FQ) course at UHM, students can transfer the MATH 150 from X University to UHM and use that course to satisfy the FQ requirement at UHM. In addition to this course-by-course articulation method, campuses in the UH system can discuss whether a common Foundations program articulation model is beneficial (see Executive Policy E5.209).

If UHM adds a Focus Quantitative Reasoning (QR) requirement, UHM will work with UH campuses to extend the Writing-intensive and Hawaiian, Asian, and Pacific Issues method for inter-campus articulation to Focus QR which would allow UH students to transfer a Focus QR course to UHM. If UH campuses are not interested, UHM will consider placing within-system transfers on the same non-system transfer pro-rated set of requirements used for Contemporary Ethical Issues and Oral Communication (see the UHM Catalog core requirements).

Other methods of fulfilling the requirement(s) will be possible and will need additional faculty input and expertise. At the foundational level, these will be considered: Advanced Placement, College Level Examination Program (CLEP), International Baccalaureate, UHM-developed exam score. If a Focus QR requirement is established, the current exemption method used for the other Focus areas will be applied to Focus QR: an extraordinary educational experience may be used (see the UHM Catalog).

D. Proposed Timeline

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<thead>
<tr>
<th>Spring 2015</th>
<th>Seek approval from the UHM Faculty Senate for the changes in general education requirements</th>
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<tbody>
<tr>
<td>Fall 2015</td>
<td>Seek approval from the Board of Regents for the changes in general education requirements</td>
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<tr>
<td>Year</td>
<td>Event</td>
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<td>2016</td>
<td>Begin QR implementation. Faculty start the process of revising Foundations Symbolic Reasoning (FS) courses to meet Foundations Quantitative Reasoning (FQ) courses; new courses proposed as FQ. Faculty begin either developing Focus QR courses (model 2) or infusing QR in appropriate courses (model 1). Develop methods for students to satisfy the QR requirement through non-course means such as an Advanced Placement exam score, SAT score, ACT score, a placement test, etc.</td>
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<td>2017-Summer 2018</td>
<td>Transition period. Overlap of FQ and FS courses: a course may be FQ or FS and either will satisfy general education requirements. The FS designation officially ends in Summer 2018. Focus QR courses are offered or QR is enhanced in appropriate courses.</td>
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<tr>
<td>Fall 2018</td>
<td>All entering UHM students have the new General Education Program requirements. Only FQ courses are offered as part of the UHM Foundations requirement. Begin program-level assessment of student learning.</td>
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### E. Definition

**Quantitative Reasoning Definition** (last updated 11/5/2014)

The definition is an adaptation of the WASC definition\(^1\) that we modified based on feedback we received from faculty at UH campuses and information from expert sources.

Quantitative reasoning (QR) is the ability to apply mathematical concepts to the interpretation and analysis of quantifiable information in order to solve a wide range of problems, from those arising in pure and applied research to everyday issues and questions. It includes the ability to do the following: apply math skills; judge reasonableness of results; understand and communicate numerical information via variables and equations, graphs and charts, words/sentences; and recognize the limits of mathematical or statistical methods.

[Note: quantifiable information can be expressed numerically or graphically]

### F. Hallmarks: Quantitative Reasoning Foundations (FQ) course

**Foundations Quantitative Reasoning Hallmarks** (updated 01/15/2015)

To satisfy a Quantitative Reasoning Foundations requirement, a course will meet these hallmarks:

1. help students value the relevance and usefulness of quantitative reasoning.

2. include practical quantitative reasoning problems that apply to specific disciplines, daily and civic life, and/or professional settings (i.e., not be purely theoretical).

3. provide opportunities for practice and feedback that are designed to help students evaluate and improve quantitative reasoning skills by including a course component with a 30:1 student to teacher ratio (e.g., a lab/recitation section, Supplemental Instruction sessions, or a class limited to 30 or fewer students).

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\(^1\) WASC, the Western Association of Schools and Colleges, published its definition of quantitative reasoning in its 2013 *Handbook on Accreditation*. See page 52 (Glossary) of the March 2013 edition.
4. be designed so that students will be able to

A. identify and convert relevant quantitative information into various forms such as equations, graphs, diagrams, tables, words;

B. make and evaluate assumptions in estimation, modeling, and data analysis;

C. calculate (including selection of appropriate formulas and correct manipulation of formulas);

D. make judgments and draw appropriate conclusions based on the quantitative analysis of data, the assumptions made, the limitations of the analysis, and the reasonableness of results;

E. create logical arguments supported by quantitative evidence; and

F. communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, etc., as appropriate).

G. Hallmarks: Quantitative Reasoning Focus course

Focus Quantitative Reasoning Hallmarks
To satisfy a Quantitative Reasoning Focus requirement, a course will meet these hallmarks:

1. The course will help students value the relevance and usefulness of quantitative reasoning in a specific discipline.

2. The course will include practical quantitative reasoning problems that apply to a specific discipline, daily and civic life, and/or professional settings (i.e., not be purely theoretical).

3. The course will be numbered 200-499.

4. The course will be limited to 30 students or a 30:1 student to instructor ratio.

5. At least 40% of the final grade for a 3-credit course will be based on student’s quantitative reasoning skills (30% for a 4-credit course; 60% for a 2-credit course; 100% for a 1-credit course).

6. be designed so that students will be able to

A. identify and convert relevant quantitative information into various forms such as equations, graphs, diagrams, tables, words;

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2 The statements listed here are adapted from the Association of American Colleges & Universities’ Quantitative Literacy VALUE rubric.

3 The statements listed here are adapted from the Association of American Colleges & Universities’ Quantitative Literacy VALUE rubric.
B. make and evaluate assumptions in estimation, modeling, and data analysis;

C. calculate (including selection of appropriate formulas and correct manipulation of formulas);

D. make judgments and draw appropriate conclusions based on the quantitative analysis of data, the assumptions made, the limitations of the analysis, and the reasonableness of results;

E. create logical arguments supported by quantitative evidence; and

F. communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, etc., as appropriate).