QUANTITATIVE REASONING (QR) DATA ANALYSIS
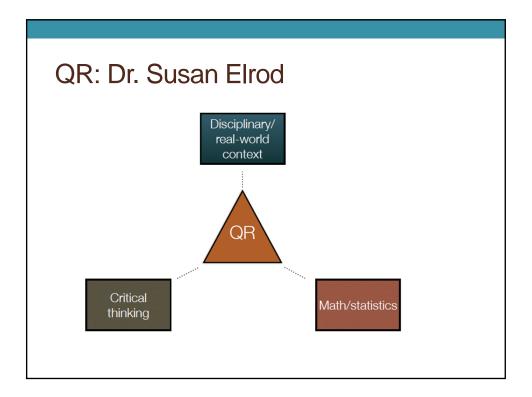
CNAS ASSESSMENT WORKSHOP

April 17th, 2015

Grazyna Badowski

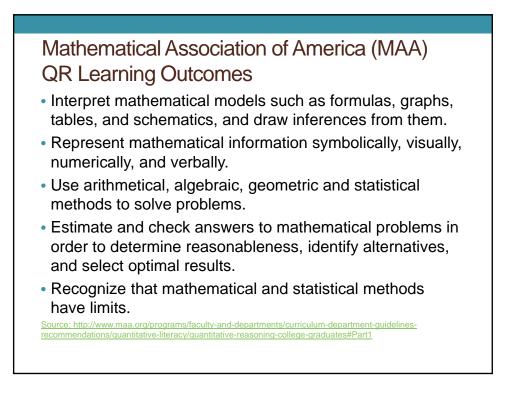# QR: What is it?

- One of WASC's five core competencies
- One of the Liberal Education and America's Promise (LEAP) essential learning outcomes
- One of UOG's ILOs
- An aspect of citizenship: How do students understand numbers in public life?
- Habit of mind, a way of thinking.

QR: Dr. Susan Elrod

Contrast between mathematics and QR

Mathematics	Quantitative Reasoning
Power in abstraction	Real, authentic contexts
Power in generality	Specific, particular applications
Some context dependency	Heavy context dependency
Society indenpendet	Society dependent
Apolitical	Political
Methods and algorithm	Ad hoc methods
Well-defined problems	Ill-defined problems
Approximation	Estimation is critical
Heavily disciplinary	Interdisciplinary
Problem solutions	Problems descriptions
Few opportunities to practice outside the classroom	Many practice opportunities outside the classroom
Predictable	Unpredictable

Source: Shavelson, R. J. (2008). Reflections on quantitative reasoning: An Assessment Perspective. In B. L. Madison & L. A. Steen. (Eds). Calculation vs. context: Quantitative literacy and its implications for teacher education, pp 27-47. Mathematical Association of America.

Mathematical Association of America (MAA) QR Learning Outcomes

• Interpret mathematical models such as formulas, graphs, tables, and schematics, and draw inferences from them.
• Represent mathematical information symbolically, visually, numerically, and verbally.
• Use arithmetical, algebraic, geometric and statistical methods to solve problems.
• Estimate and check answers to mathematical problems in order to determine reasonableness, identify alternatives, and select optimal results.
• Recognize that mathematical and statistical methods have limits.

Source: http://www.maa.org/programs/faculty-and-departments/curriculum-department-guidelines-recommendations/quantitative-literacy/quantitative-reasoning-college-graduates#Part1

QR at UOG

- QR is one of UOG's ILOs.
- It was stated as: "Mastery of quantitative analysis"
- In Fall 2014, University Assessment Committee (UAC) worked on clarifying statements for the University ILOs

Clarifying statements for QR at UOG

BEFORE: "Mastery of quantitative analysis"
NOW: Upon completion of degree, a University of Guam student will be able to :

1. Provide accurate explanations of information presented in mathematical forms. Make appropriate inferences based on that information.
2. Convert any relevant information into various meaningful mathematical forms (equations, graphs, diagrams, tables, words).
3. Identify and propose solutions for problems using quantitative tools and reasoning using calculations.
4. Use the quantitative analysis of data as the basis for deep and thoughtful judgments, drawing insightful, carefully qualified conclusions from this work.
5. Explicitly describe assumptions and provide compelling rationale for why each assumption is appropriate.
6. Use quantitative information in connection with the argument or purpose of the work, present it in an effective format, and explicates it with consistently high quality.

UOG Clarifying statements for ILOs: Example

Translate verbal problems into mathematical algorithms, constructs valid arguments using the accepted symbolic system of mathematical reasoning, and constructs accurate calculations, estimates, risk analyses or quantitative evaluations of public information through presentations, papers or projects. (Quantitative fluency)
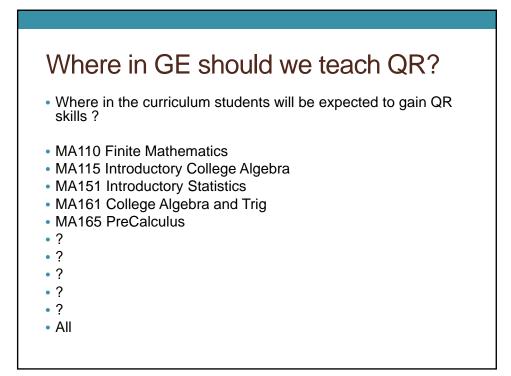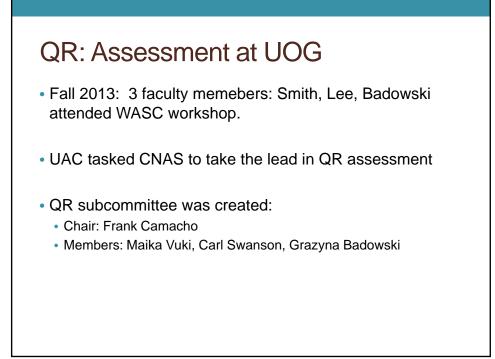
QR at UOG

QR in GE Learning Outcomes?

UOG students will be able to apply analytical and QR reasoning to address complex challenges and everyday problems by:
1. Interpreting information presented in a mathematical and graphical form;
2. Representing information in a mathematical and graphical form;
3. Effectively calculating using quantitative data;
4. Analyzing quantitative information in order to scrutinize it and draw appropriate conclusions;
5. Evaluating the assumptions used in analyzing quantitative data
6. Communicating quantitative information in support or refutation of an argument.

• Where in the curriculum students will be expected to gain QR skills ?

Where in GE should we teach QR?

- Where in the curriculum students will be expected to gain QR skills ?

- MA110 Finite Mathematics
- MA115 Introductory College Algebra
- MA151 Introductory Statistics
- MA161 College Algebra and Trig
- MA165 PreCalculus
- ?
- ?
- ?
- ?
- ?
- All

QR: Assessment at UOG

- Fall 2013: 3 faculty memebers: Smith, Lee, Badowski attended WASC workshop.

- UAC tasked CNAS to take the lead in QR assessment

- QR subcommittee was created:
  - Chair: Frank Camacho
  - Members: Maika Vuki, Carl Swanson, Grazyna Badowski

QR Assessment at UOG, Spring 2014

- Used the test developed by Dr. Eric Gaze, Director of the Quantitative Reasoning at Bowdoin University.
  - ➤The test has 20 multiple choice questions.
  - ➤It also has **five attitudinal questions**.

- Assessed students at the end of Spring 2014 in MA110, 115, 151, 161A, and 165 to get some baseline data.
- Assessed seniors at the end of Spring 2014 in selected capstone courses.
- We will track the students.

QR at UOG Spring 2014. Data analysis.

		Frequency	Percentage
SEX	**Male**	124	49%
	Female	131	51%
LEVEL	**100-200**	125	49%
	300-400	128	50%
DELIVERY	**online**	140	55%
	paper	115	45%

QR at UOG Spring 2014. Data analysis.

COURSE	N	Mean	Std. Deviation
MA165	6	21.7%	9.8%
MA110	10	22.0%	9.2%
MA115	4	27.5%	11.9%
MA151	50	30.1%	17.9%
MA161A	25	32.6%	15.2%
BI310	21	36.9%	16.8%
CO491	8	38.1%	22.8%
MA385	16	38.8%	23.0%
CS315	21	50.0%	21.3%
MA203	30	50.5%	22.8%
BI333	14	54.3%	24.2%
BI410	5	57.0%	12.0%
CH310	24	61.3%	20.4%
CS425	5	65.0%	23.7%
MA422	14	67.5%	17.1%
NA	2	62.5%	46.0%
Total	**255**	**43.0%**	**23.1%**

QR at UOG Spring 2014. Data analysis by level.

Level	N	Mean	Std. Deviation
Lower	125	34.4%	20.0%
Upper	128	51.1%	22.7%

Level_3	N	Mean	Std. Deviation
100-level	95	29.3%	16.0%
200-level	30	50.5%	22.8%
300-400	128	51.1%	22.7%

Note: 200-level students were mostly calculus students

QR at UOG Spring 2014. Data analysis.

MA085	N	Mean	Std. Deviation
no	172	49.9%	22.9%
yes	83	28.5%	15.8%
Total	255	43.0%	23.1%
p-value=0			

Students who reported having taken a developmental mathematics course scored significantly lower than those who did not require developmental mathematics.

MA151	N	Mean	Std. Deviation
No	166	41.5%	23.5%
Yes	89	45.6%	22.3%
P-value=.18			

Students who reported having taken MA151 Basic Statistics course scored higher than those who did not although the difference is not statistically significant.

QR at UOG Spring 2014. Data analysis.

MAJOR	N	Mean	Std. Deviation
Math/Science	135	47.7%	23.4%
Social Science	33	31.5%	19.7%
Humanities	10	34.5%	19.1%
Engineering/Technology	29	44.7%	21.8%
Other	21	35.7%	23.8%
Total	228	43.3%	23.3%

QR at UOG Spring 2014. Data analysis by question.

Percent Correct

QR at UOG Spring 2014. Data analysis.

Percent Correct by level

QR at UOG Spring 2014. Data analysis.

Comparison of UOG QR Data with other Institutions

Institution	N	Mean %	St. Dev%
2-Year	273	39.3	20.2
Selective 4-year	1088	59.7	22.8
Non-selective 4-year	811	30.1	17.9
UOG	255	43.0	23.1
Total:	2,427	43.0	22.8

Other QR Student Learning Outcomes

1. View mathematics with heightened interest, increased confidence, and less anxiety as a result of their educational experiences.
2. Regard mathematics as a way to think, reason and conceptualize, not simply as a set of techniques.
3. Understand and appreciate the connections between mathematics and a variety of quantitative and non-quantitative disciplines.

Attitudes

Numerical information is useful in everyday life	56.5% Strongly Agree
Numbers are not necessary for most situations.	23.9% Strongly Disagree
Quantitative information is vital for accurate decisions.	38.8% Strongly Agree
Understanding numbers is as important in daily life as reading and writing.	63.1% Strongly Agree
It is a waste of time to learn information containing a lot of numbers.	53.7% Strongly Disagree

Relationship between attitude score and QR test score.