

CAA Quantitative Goal Subcommittee  
Tuesday, April 1, 2014

## Quantitative Reasoning Learning Goal

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### QR Learning Goal Committee Members

- Wesley Allan - Psychology
- Alejandra Alvarado - Mathematics
- Marita Gronnvoll – Communication Studies
- Mary Konkle - Chemistry
- Michael Menze – Biological Sciences
- Kevin Savage – Graduate Student Dean
- Krishna Thomas – Faculty Development
- Larry White – School of Business

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### Today's Schedule

- Quantitative Reasoning Learning Goal
- Principles and Best Practices in the Teaching of Quantitative Reasoning
- Principles and Best Practices in the Assessment of Quantitative Reasoning
- Small Group Discussion of Strategies for Implementing Quantitative Reasoning into the Classroom

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### Definition of Quantitative Literacy

- A "habit of mind," competency and comfort in working with numerical data
- Individuals with strong QL skills:
  - Can reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations
  - Can understand and create sophisticated arguments supported by quantitative evidence
  - Can clearly communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, as appropriate)

The diagram consists of three colored circles (light blue, pink, and light green) arranged vertically. Each circle is connected to a corresponding colored rectangular box containing text. The top blue circle connects to a box labeled 'Engagement with the World'. The middle pink circle connects to a box labeled 'Ability to apply quantitative ideas in unfamiliar contexts'. The bottom green circle connects to a box labeled 'Flexible understanding that adapts readily to new circumstances'.

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### Quantitative Reasoning Learning Goal

- EIU graduates produce, analyze, interpret, and evaluate quantitative material by:
  - Performing basic calculations and measurements.
  - Applying quantitative methods and using the resulting evidence to solve problems.
  - Reading, interpreting, and constructing tables, graphs, charts, and other representations of quantitative material.
  - Critically evaluating quantitative methodologies and data.
  - Constructing cogent arguments utilizing quantitative material.
  - Using appropriate technology to collect, analyze, and produce quantitative materials.

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### Benchmarking/Common Core

- The Standards for Mathematical Practice
  - MP1: Make sense of problems and persevere in solving them
  - MP2: Reason abstractly and quantitatively
  - MP3: Construct viable arguments and critique the reasoning of others.
  - MP4: Model with mathematics
  - MP5: Use appropriate tools strategically
  - MP6: Attend to precision
  - MP7: Look for and make use of structure
  - MP8: Look for and express regularity in repeated reasoning

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### Where Are We?

- National Assessment of Adult Literacy (NAAL) 2003 Survey:
  - Only 13% of adults ages 16 and over demonstrated proficiency in quantitative literacy
  - QL disadvantage was most evident among females and economically disadvantaged minorities
- Organisation for Economic Co-Operation & Development (OECD) 2013 Survey of Adult Skills (including numeracy):
  - Young adults (16 to 24 years) scored lowest
  - Lowest scoring countries - Italy, Cyprus, United States

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### Where Are We?

- 2010 Hart Research survey of employers
  - 63% reported that they seek employees who can understand and work with numbers and do statistics
  - 55% reported that colleges should place more emphasis on helping students understand numbers and statistics
  - Of 17 learning outcomes, employers say that colleges should place more emphasis on the following areas:
    - Critical thinking & analytical reasoning (82%)
    - Complex problem solving and analysis (81%)

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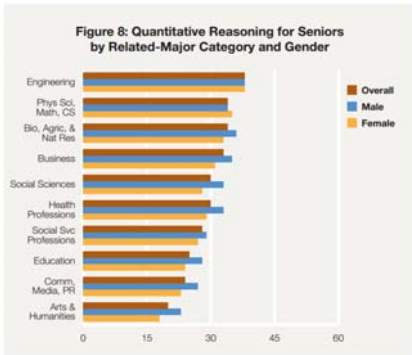
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Most likely to use QR in their courses (NSSE data)  
Source: National Survey of Student Engagement

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## Where Are We?

- "Thus, quantitative material needs to permeate the curriculum, not only in the sciences but also in the social sciences and, in appropriate cases, in the humanities, so that students have opportunities to practice their skills and see how useful they can be in understanding wide range of problems."
  - Derek Bok

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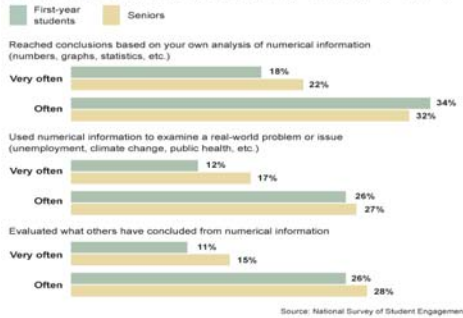
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### Quantitative Reasoning Among Freshmen and Seniors

This year's Nessesie survey included several new questions aimed at measuring how frequently students use quantitative reasoning, considered a vital skill for the workplace and for civic engagement, in their coursework.

Percentage of students who responded that they "very often" or "often" ...




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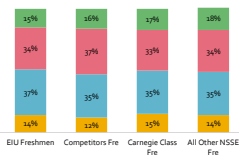
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## NSSE 2013 EIU Students Survey Freshman N=199, Senior N=381

### FRESHMEN

6.a. Reached conclusions based on your own analysis of numerical information (numbers, graphs, statistics, etc.)?

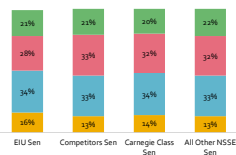
Legend: Never, Sometimes, Often, Very often



### SENIORS

6.a. Reached conclusions based on your own analysis of numerical information (numbers, graphs, statistics, etc.)?

Legend: Never, Sometimes, Often, Very often




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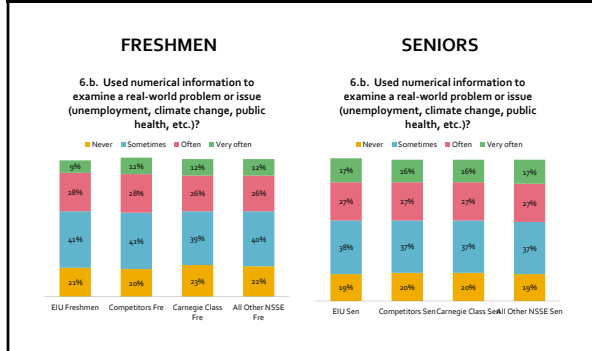
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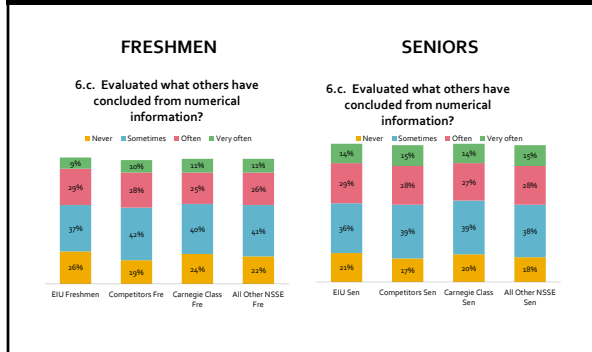
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The following best practices and principles come from:

- NICHE – Numeracy Infusion Course in Higher Education
- Lutsky, Neil. Teaching Quantitative Reasoning. Association of Psychological Science.

Principles and Best Practices in Teaching QR

"The world of the twenty-first century is a world awash in numbers."  
Lynn Steen (2002, 2)

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### True Story

- Dinner bill came out to \$48, to be split among 6 people (one person was paying for two).
- One person paid  $2 \times 8 = 16$ , so the remaining bill was \$32 to be split among four.
- Server was adamant each person was responsible for \$12, probably because the server clicked on the "split check" button for the entire bill.
- Server called the manager to help, instead of relying on quantitative reasoning.

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### Four Interrelated Aspects of Quantitative Reasoning



Wolfe, C. "Quantitative Reasoning Across a College Curriculum"

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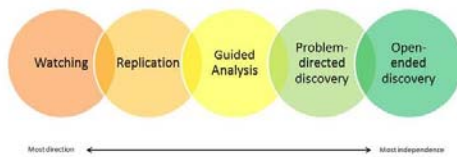
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### Learning From Data

- Continuum of how students can engage the data.



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## Quantitative Expression

- Common mistake is the conversion error: "all dogs are animals" imply "all animals are dogs"
- An American youth is more likely to become president than to die on an airplane flight. What does this mean?

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## Evidence & Assertions

*A plunge in U.S. preschool obesity? Not so fast, experts say*  
(Sun, Mar 16, 2014)

- The prevalence of obesity among American preschoolers has plunged 43 percent in a decade. (Journal of American Medical Association)
- Similar studies find no such decrease in obesity among preschoolers.
- The 43 percent headline figure refers to the drop from the 13.9 percent rate in 2003-04 to the 8.4 percent rate in 2011-2012.
- The 2011-2012 version of the survey included 9,120 people; 871 of them were 2 to 5 years old. US over 300 million; about 18 million under age 5.
- The WIC program in California's Los Angeles County, researchers found that the problem worsened from 2003 to 2011. Sample size 200,000.



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## Quantitative Intuition

- An appropriate sense of scale. (ball park estimates)
  - Instead of asking how old in years someone is, estimate how old in days.
  - What is the distance from Charleston to Seattle?

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### 1. Real World Applications & Active Learning, including Discovery

- Use real-world applications
  - Political polling
  - Clinical trials
  - Tax policy
  - Fighting terrorism
  - Building roads
  - Cancer screening
- Use active learning, including discovery methods
  - Role play in a case-study
  - Data-simulations
  - Create “personally meaningful” experiences that enable students to connect new knowledge to what they already believe or understand

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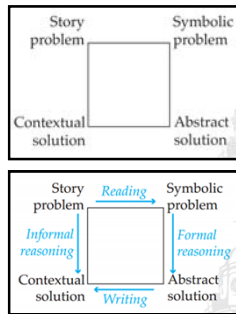
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### 2. Pairing QR instruction with Writing, Storytelling & Critical Reading

- Madison (2012):
  - Strengthen academic arguments;
  - Strengthen quantitative literacy/reasoning;
  - Interpret and improve public discourse;
  - Encourage quantitative reasoning across the curriculum; and
  - Prepare students for the workplace.
- Quantitative Writing Assignments
  - Sample assignments in handout
  - Backwards-design of assignments



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### 3. Using Technology, including Computers

- Use of Technology
  - Discipline-specific tools
  - Survey software
  - Turnitin
- Teaching with Spreadsheets Across the Curriculum
  - Sample assignment in Handout
- What’s available on Campus:
  - MS Excel, Access
  - SPSS
  - Qualtrics

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#### 4. Collaborative Instruction & Group Work

- Using groups for QR assignments
- Caulfield and Hodges (2006: 52) reported, "Our data clearly reveal that most of our students work harder and learn more while working in groups." (teaching social science research & quantitative reasoning)

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#### 5. Pedagogy that is sensitive to cultures & learning styles

I. Provide Multiple Means of Representation

1. Provide options for perception
  - 1.1 Offer ways of assessing the display of information
  - 1.2 Offer alternatives for auditory information
  - 1.3 Offer alternatives for visual information
2. Provide options for language, mathematical expressions, and symbols
  - 2.1 Clarify vocabulary and symbols
  - 2.2 Clarify syntax and structure
  - 2.3 Support decoding of text, mathematical notation, and symbols
  - 2.4 Promote understanding across languages
  - 2.5 Illustrate through multiple media
3. Provide options for comprehension
  - 3.1 Activate or supply background knowledge
  - 3.2 Highlight patterns, critical features, big ideas, and relationships
  - 3.3 Guide information processing, visualization, and manipulation
  - 3.4 Maximize transfer and generalization

Remember! knowledgeable learners

- Collaborative learning
- Provide multiple means of representation (UDL)
- Teach students how to seek quantitative information
  - Collaborate with reference librarians to find sources of relevant quantitative information

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#### 6. Scaffolding the Learning Process, providing rich feedback & revision

- Killen (2006): "providing a student with enough help to complete a task and then gradually decreasing the help as the student becomes able to work independently"
- Salomone, M.
  - Handout: Quantitative Reasoning Skill Scaffold
- Provide ample opportunity to master the material
- Similarly, revision as an essential component in WAC curriculum

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### Recap: Best Practices & Principles

1. Real World applications and active learning, including discovery methods
2. Pairing QR instruction with writing, storytelling and critical reading
3. Using technology, including computers
4. Collaborative instruction & group work
5. Pedagogy that is sensitive to students' culture & learning styles
6. Scaffolding the Learning Process & providing rich feedback & opportunities for revision

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### Principles and Best Practices in Assessment of QR

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### Best Practices in Assessment

- Bowdoin College (Maine)
  - QR Exam
    - Instead of using procedural questions, should use questions that require more involved reasoning and critical thinking skills
    - Request that students interpret tables and charts rather than providing the information for them
    - Focus on using numbers in context rather than simple computation and math skills
    - Ask students to postulate potential explanations for statistics

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## Best Practices in Assessment

- Hollins University (Virginia)
  - Use clear rubrics
    - Based on AAC&U VALUE rubric
      - Assess/grade students based on:
        - Interpretation
        - Representation
        - Calculation
        - Analysis/Synthesis
        - Assumptions
        - Communication

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## Best Practices in Assessment

- Carleton College (Minnesota)
  - "Because QR itself is grounded in context, our assessment tools must be as well" (Grawe, 2011; p. 50)
    - Complex QR skills such as the ability to construct arguments with quantitative evidence are best assessed by essays or oral presentations
      - Multi-choice exams can be useful but only if the options are context-rich
    - QR is multi-faceted and requires multi-faceted assessment
      - Multiple tools

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## Best Practices in Assessment

An article about the US Postal Service in the New York Times on December 4, 2011 stated that:

First-class mail — items like bills and letters that require a 44-cent stamp — fell 6.6 percent in 2010 alone, continuing a five-year-long plunge. Last year...there were 9.3 billion pounds of 'standard mail' — the low-cost postage category available to mass advertisers — but only 3.7 billion of first-class mail.

[www.nytimes.com/2011/12/04/sunday-review/the-junking-of-the-postal-service.html](http://www.nytimes.com/2011/12/04/sunday-review/the-junking-of-the-postal-service.html)

a. A graphic next to the article said that standard mail in 2010 amounted to 30.3 pounds for every adult and child in the US. Verify this 30.3 pounds per person figure.

b. How many pounds of first class mail did the Post Office deliver in 2009?

c. First class mail mostly consists of bills, credit card statements, personal letters and greeting cards. First class postage is 44 cents for the first ounce and 20 cents for each additional ounce. Estimate the total cost of the postage on first class mail in 2010.

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### Best Practices in Assessment

2 = full understanding; 1 = partial understanding;  
0 = little or no understanding

Demonstrated ability to identify and extract relevant data from complex verbal text and apply it to problems.

Able to verify textual claims through an appropriate set of calculations.

Accurately performed backward percentage calculation to determine a prior year value.

Performed a complex calculation involving estimation and multiple unit conversions.

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### Best Practices in Assessment

- Many programs posit the importance of assessing attitudes and beliefs about mathematics and quantitative literacy
- These attitudes and beliefs are too often a stumbling block to student success

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### Best Practices in Assessment

- Expect that students will make the most progress in discipline-specific skills
  - For example, social science majors show greatest improvement in statistical reasoning; whereas greater gains in the understanding of conditional logic is shown by natural science and humanities majors

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### Best Practices in Assessment

- U. of Massachusetts at Boston
  - Student self-assessment of technical skills and QR skills
  - Also assess attitudinal change

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12. As a result of the course my ability to:	Is about the same	Is Improved	Is much improved
a. Attach documents to email.....	_____	_____	_____
b. Use Excel to analyze data.....	_____	_____	_____
c. Use a word processor.....	_____	_____	_____
d. Use the Internet to obtain information.....	_____	_____	_____
e. Cut/paste and download data from the Internet.....	_____	_____	_____
f. Read and understand graphs.....	_____	_____	_____
g. Draw conclusions from datasets.....	_____	_____	_____
h. Work with formulas.....	_____	_____	_____
i. Work with very large and very small numbers.....	_____	_____	_____
j. Use data to construct a convincing argument.....	_____	_____	_____

13. Do you find that you now read newspaper or magazine articles that contain data, charts or graphs more critically? Yes \_\_\_\_\_ No \_\_\_\_\_

14. Check any of the boxes below that apply to you:

	I would be comfortable applying this in another course or in my employment	I have already applied this in another course or on-the-job (if so, specify the course or the kind of job)
a. Evaluating quantitative claims and the evidence presented in their support.....	_____	_____
b. Using Excel to organize and analyze data.....	_____	_____
c. Producing reports that use data, charts or graphs to support conclusions or arguments.....	_____	_____
d. Using technology learned in this class.....	_____	_____

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### Best Practices in Assessment

- Finally, require that students write about data
- Thinking about how to translate numerical information into words (without relying on jargon) can strengthen computational and interpretive skills (Beins, 1993)

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**Teaching: Applied?**

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**Discuss...**

- What challenges do you believe that you could face, or have faced, in implementing quantitative reasoning in your classes?
- AND/OR
- How have you already implemented quantitative reasoning in your classroom?

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**Brainstorm**

- Challenges?
  
- Suggestions?

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## News of the Day\*

For this assignment, you will find a media news article that contains quantitative data in support of its claims. You will:

- Summarize the central claims of the article
- Convert the quantitative data into meaningful charts/graphs that bring the numbers to life for the class
- Evaluate the quantitative evidence, e.g., where does the data come from? Are the studies/polls reliable? This last step will be interactive with the class members their SmartPhones/laptops/notebooks to research the data.
- Come to a conclusion about the strengths/weaknesses of the article

\*Dingman, S.W. & Madison, B.L. "Twenty-first-century quantitative education: Beyond content." *Peer Review* (Summer 2011).

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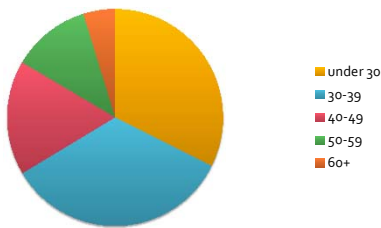
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## Student Loan Debt Statistics

WHO IS BORROWING?

Billions in Debt



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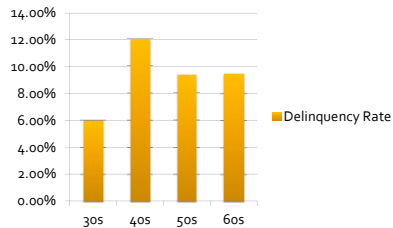
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## Student Loan Debt

Delinquency Rate



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### "By/On the Margins: Perspectives on Power, Oppression, and Liberation"\*

The purpose of this assignment is to illustrate how students can use quantitative reasoning to gain insight into the difficulties presented by living in poverty.

- Students will be given information about the family composition and income for a hypothetical poverty-level family of four living in Coles County, IL
- Students will determine where they would live, work, shop, travel from place to place
- Students will develop a monthly budget for the family, including food, housing, transportation, utilities, and medical expenses

\*Wolfe, C.R. "Quantitative reasoning across a college curriculum." *College Teaching*, 41 (1993), pp. 3-9.

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### QR Group Member Emails

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| ▪ Wesley Allan<br>▪ <a href="mailto:wallan@eiu.edu">wallan@eiu.edu</a>               | ▪ Michael Menze<br>▪ <a href="mailto:mmenze@eiu.edu">mmenze@eiu.edu</a>      |
| ▪ Alejandra Alvarado<br>▪ <a href="mailto:aalvaredo2@eiu.edu">aalvaredo2@eiu.edu</a> | ▪ Kevin Savage<br>▪ <a href="mailto:kpsavage@eiu.edu">kpsavage@eiu.edu</a>   |
| ▪ Marita Gronnvoll<br>▪ <a href="mailto:mgronnvoll@eiu.edu">mgronnvoll@eiu.edu</a>   | ▪ Krishna Thomas<br>▪ <a href="mailto:kpthomas@eiu.edu">kpthomas@eiu.edu</a> |
| ▪ Mary Konkle<br>▪ <a href="mailto:mekonkle@eiu.edu">mekonkle@eiu.edu</a>            | ▪ Larry White<br>▪ <a href="mailto:lwhite2@eiu.edu">lwhite2@eiu.edu</a>      |

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CAA Quantitative Goal Subcommittee  
Tuesday, April 1, 2014

### Quantitative Reasoning Learning Goal

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