

Quantitative Reasoning

or

Quantitative Literacy

Workshop

Quantitative Reasoning Working Group

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A General Mission Statement /

Definition



Quantitative Literacy(QL) – also known as Quantitative Reasoning (QR) – is a “quantitative habit of mind”, proficiency, and comfort in dealing with and rationally processing numerical data. Individuals with strong QL skills possess the ability to analyze quantitative problems in everyday life situations using logical reasoning steps. They are able to read and understand numerical data. They can create valid arguments based on quantitative evidence and know how to interpret their conclusions. They are capable of clearly communicating their analyses and arguments in a variety of formats (including words, tables, graphs, mathematical equations and models, as appropriate).

Expanded definition:

The formal definition of Quantitative Literacy implies competency in different fields of basic mathematics, and their application to diverse problems in the sciences, business and administration, politics, economics, and in everyday life. Most importantly, QL requires an understanding of the mathematics that is deeper than mere memorization of, and facility with, calculation procedures. Possession of strong QL skills requires competency in critical areas:

**1. Approximation / estimation –
The ability to do effective
approximation and estimation.**

2. Mathematical models – The ability to understand the assumptions behind mathematical models, and the implications that those assumptions have for the validity and scope of conclusions that are drawn.

3. Tables and graphs – The ability to represent and understand data in graphical forms and other visual representations.

4. Algebra – The ability to understand and manipulate algebraic equations, including the ability to draw conclusions from functional dependencies. Competency in this area thus goes beyond the ability to substitute for known variables and to perform the requisite arithmetic.

5. Geometry – The ability to think and visualize in higher dimensions, including an understanding of the dependencies of geometric properties, such as volume, on the dimensions of the shapes. The ability to express properties in terms of angles.

6. Statistics – The ability to draw appropriate conclusions from statistical data, including an understanding of statistical distributions and properties such as average, median, and standard deviation. The ability to incorporate uncertainties in the data when drawing conclusions.

Rubrics



We have developed some rubrics for various aspects of Quantitative Reasoning:

Assessment of Overall Quantitative Literacy (1)

Topic	Proficient	Adequate	Deficient
Logical Quantitative Reasoning and Analysis	Can understand problems and develop their own innovative logical quantitative analyses	Can follow and reproduce logical quantitative analyses	Analyses are based principally on random thoughts and guesswork

Assessment of Overall Quantitative Literacy (2)

Topic	Proficient	Adequate	Deficient
Validity, applicability, and limitations of quantitative arguments	Adept at developing valid quantitative arguments and understanding their assumptions, applicability, and limitations	Can apply learned arguments to similar problems, but also tries to apply them to problems which are beyond the scope of the argument / analysis	Tries to solve all problems using the same strategies without adaptation.

Assessment of Specific Literacies

1. Approximation / Estimation

Proficient	Adequate	Deficient
Can effectively perform meaningful and novel estimates and approximations.	Can incorporate estimated data to estimate expected results.	Over reliance on calculators. Views all answers as precise. Unable to distinguish between accuracy and precision.

2. Mathematical / Quantitative Models

Proficient	Adequate	Deficient
Can analyze a real world example sufficiently to conceptualize a simulation of the system, which is complex enough to give meaningful results, but simple enough to be understandable.	Can simplify complex models to obtain approximate results and understand the limitations imposed by that approximation.	Can recognize and appreciate meaningful use of models to understand the world at large.

3. Tables and Graphs

Proficient	Adequate	Deficient
Can understand data presented in tabular or graphical form, and recognize trends in data. Understands the validity of extrapolation. Can develop sketch graphs.	Can extract relevant data from tables or graphs, and interpolate, but without ability to see the overall picture. Recognize importance of scales, labels, and error bars.	Can retrieve data from tables. Fails to recognize importance of scales, labels, and error bars.

4. Algebraic / Symbolic Approaches

Proficient	Adequate	Deficient
Understands functional relationships, can manipulate symbols, and can draw conclusions from each. Can effectively solve novel word problems.	Can reliably manipulate algebraic / symbolic expressions. Can handle more than one equation at a time. Can identify and apply similar methods to corresponding word problems.	Can only “plug and chug”. Makes frequent mistakes when manipulating equations. Cannot do word problems.

5. Geometry

Proficient	Adequate	Deficient
Can visualize in three dimensions. Can scale shapes. Effective at applying geometric methods to specific problems.	Can visualize above two dimensions only for simple shapes. Unable to scale shapes. Competent at using angular measurements in multiple dimensions.	Confusion about differences between volume and area. Difficulty with angular measurements.

6. Statistics and Probability

Proficient	Adequate	Deficient
<p>Can interpret data in other (“non-normal”) distributions. Understands the validity and limitations of sampling methods including the chance of false positives. Familiarity with probabilistic reasoning.</p>	<p>Can interpret data in a normal distribution, including concepts such as mean, mode, median, and standard deviation. Understands basic ideas of sampling methods and error analysis.</p>	<p>Understands simple average, but does not distinguish mean, mode, median. Is unfamiliar with standard deviation. No clear understanding of sampling methods and error analysis.</p>



<http://csustan.csustan.edu/~tom/>



References

- [1] AACU
Quantitative Reasoning
<https://www.aacu.org/peerreview/2014/summer>

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