Quantitative Literacy Rubric (2017)				
	Advanced (3)	**Developing (2)**	**Emerging (1)**	**Initial (0)**
1. Interpret situations and problems mathematically, in terms of their quantities and relationships. This includes identifying quantities, variables, and constraints of the situation, representing these mathematically, and making appropriate assumptions.	Makes reasonable assumptions, and fully justifies them based on the context and appropriately selected evidence. Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a further or deeper understanding.	Makes reasonable assumptions, and justifies them based on context and some evidence. Competently converts relevant information into an appropriate and useful mathematical portrayal.	Makes some reasonable assumptions with incomplete justifications. Converts information into a mathematical portrayal, but has included irrelevant information or the mathematical portrayal is only partially appropriate, accurate, or useful.	Makes incomplete or unreasonable assumptions and/or representations, with little or no description of relationships.
2.Reason about and analyze mathematical relationships in contextual situations. This includes identifying relationships among the variables, interpreting the meaning of the relationships in the context, and evaluating the reasonableness of these relationships in the context.	Correctly and succinctly analyzes mathematical relationships of variables derived from a given context, identifying meaningful relationships among all relevant variables, interpreting the meaning of these relationships in the context, and accurately evaluating their reasonableness in the context.	Provides correct analysis, though may be overly complicated or may include extraneous or irrelevant information. Identifies mostly appropriate relationships among most relevant variables.	Provides some appropriate reasoning, but incomplete and/or may also have faulty reasoning.	Does not reason or analyze, or uses primarily faulty reasoning.
3.Develop logical arguments about quantities in context, supported by (quantitative) evidence. This includes interpreting the mathematical relationships in terms of the context, setting up and carrying out appropriate computations, interpreting the results in terms of the situation, and evaluating their reasonableness in the context.	Creates correct and concise mathematical arguments that utilize appropriate relationships among the variables, accurate computation, and correct interpretation of the result in terms of the context. Validates the result as reasonable in the context.	Creates (mostly) correct mathematical arguments based on reasonable relationships among the variables, (mostly) correct computation and interpretation in terms of the context. Makes unclear or incomplete attempts to validate the result in the context.	Creates partially correct mathematical argument based on some relationships between the variables, (mostly) correct computation and interpretation. Does not validate the result in the context.	Provides unclear argument, incorrect or no relationships among the variables, unclear or incorrect computations. Does not attempt to validate the result in the context.
4.Critique logical arguments about quantities in context. This includes developing an understanding of the argument, analyzing its logical construction, and evaluating the validity of the assumptions and conclusions of the argument in relation to the context.	Develops clear and pertinent critique of logical arguments, revealing a deep understanding of the argument and its logical construction. Provides appropriate evaluation of the assumptions and conclusion of the argument as they relate to the context.	Develops critique of the logical arguments that reveals an understanding of most of the reasoning. Provides evaluation of most of the assumptions and conclusions of the argument as they relate to the context.	Develops overall critique of the argument, but may miss important points. Evaluates some of the assumptions and conclusions, but may not tie them carefully to the context.	Provides (at most) a general opinion on the validity of the argument and its assumptions and conclusion
5.Communicate ideas and arguments orally and in writing, using mathematical language and representations such as graphs, symbols, and geometric figures.	Communicates mathematical ideas and arguments orally and in writing precisely, clearly and concisely, utilizing mathematical language and representations (such as graphs, symbols, and geometric figures) that are appropriate mathematically and well suited to the audience and purpose of the communication.	Communicates mathematical ideas and arguments clearly, using mostly appropriate mathematical language and representations.	Communicates mathematical arguments, using some mathematical language and representations.	Communications vaguely, without clear use of mathematical language and representations.

CSUSB Quantitative Literacy GE Learning Outcome

What does the GLO mean?

Quantitative literacy is a synthesis of habits of mind and skills through which people understand, critique, and create logical arguments about quantities in various contexts and disciplines, often for the purpose of decision-making. They do so using, for example, logical, graphical, algebraic, geometric, statistical, and computational methods, and they communicate their reasoning and results clearly, utilizing a variety of mathematical representations.

Dimensions of quantitative literacy:

1. Interpret situations and problems mathematically, in terms of their quantities and relationships. This includes identifying quantities, variables, and constraints of the situation, representing these mathematically, and making appropriate assumptions.
2. Reason about and analyze mathematical relationships in contextual situations. This includes identifying relationships among the variables, interpreting the meaning of the relationships in the context, and evaluating the reasonableness of these relationships in the context.
3. Develop logical arguments about quantities in context, supported by (quantitative) evidence. This includes interpreting the mathematical relationships in terms of the context, setting up and carrying out appropriate computations, interpreting the results in terms of the situation, and evaluating their reasonableness in the context.
4. Critique logical arguments about quantities in context. This includes developing an understanding of the argument, analyzing its logical construction, and evaluating the validity of the assumptions and conclusions of the argument in relation to the context.
5. Communicate ideas and arguments orally and in writing, using mathematical language and representations such as graphs, symbols, and geometric figures.

Notes:

1. The term "quantitative literacy" is used synonymously with "quantitative reasoning" or "numeracy" (or even "statistical literacy") in many places. Perspectives on the meanings of these terms vary widely, from a fairly narrow interpretation as skills in carrying out computation and interpreting results to a rather broad one involving a variety of mathematical reasoning and communication habits of mind and skills. We chose to adopt the broader view of the term for purposes of the CSUSB General Education Learning Outcomes, in line with the ASCSU Task Force on Quantitative Reasoning report from September 1, 2016. See the list of resources at the end of this document for this report as well as additional documents and perspectives.
2. Quantitative literacy is often a crucial tool in making evidence-based decisions. With that in mind, we include decision-making as a major purpose for the activities involved in quantitative literacy.

What should courses that seek certification as a GE course that satisfies this GLO include?

Courses that satisfy the Quantitative Reasoning GLO should address the definition and dimensions listed on the previous page. They should provide a foundation in concepts and skills of quantitative literacy that will support its application in a wide variety of contexts and disciplines. In particular, they should also include:

1. Problems that involve realistic situations in a variety of disciplines; for example

a. Decision-making based on (possibly incomplete) information
b. Comparing viability and desirability of different proposals
c. Analyzing reliability and possible bias of media reports involving quantities

Please see also the list of problems in the Steen paper referenced below.

2. Assignments related to a variety of disciplines that

a. Require authentic, independent, interpretation of a quantitative context (as opposed to, for example, solving a list of problems by substituting numbers into a given formula)

b. Interpretation of the results and communication of conclusions verbally, utilizing appropriate mathematical representations

3. A mechanism for authentic and timely feedback to students on their interpretations, reasoning, conclusions, and communication. Note: not all feedback must be given by the instructor; for example, peer feedback can be very powerful (but needs to be set up well.)

What do we want our students to become in terms of this GELO? What should CSUSB graduates know and be able to do in terms of this GLO?

The paper "The Case of Quantitative Literacy" prepared by Lynn Arthur Steen on behalf of a Quantitative Literacy Design Team (see paper for reference) provides a good description of what QL is (and isn't), along with examples of the types of things we would expect students to do as quantitatively literate graduates. The discussion of skills is included here (from pages 15-17 of the report):

Skills of Quantitative Literacy

For a different and more traditional perspective on quantitative literacy, we might create an inventory of quantitative skills expected of an educated person in contemporary society. For many, a list of skills is more comforting than a list of elements or expressions because skills are more immediately recognizable as something taught and learned in school. Moreover, many people believe that skills must precede applications and that once learned, quantitative skills can be applied whenever needed. Unfortunately, considerable evidence about the associative nature of learning suggests that this approach works very imperfectly. For most students, skills learned free of context are skills devoid of meaning and utility. To be effective, numeracy skills must be taught and learned in settings that are both meaningful and memorable.

Nevertheless, a list of skills is a valuable enhancement to our emerging definition of quantitative literacy—a third dimension, so to speak, which complements the foregoing analyses in terms of elements and expressions. A list of skills helps instructors plan curricula to cover important topics and helps examiners assess the desired balance of knowledge. An appendix to the Mathematical Association of America's report on quantitative literacy (Sons, 1996) offers—with suitable apologies and caveats—a consensus among mathematicians on skills that are especially important for courses in quantitative literacy. This list includes predictable topics from arithmetic, geometry, and algebra that are part of every school mathematics program, but it also includes many newer topics from statistics and optimization that are usually offered to students, if at all, only as electives.

In fact, many of these "elective" skills are firmly embedded in the elements and expressions of quantitative literacy. They include:

- *Arithmetic: Having facility with simple mental arithmetic; estimat- ing arithmetic calculations; reasoning with proportions; counting by indirection (combinatorics).*
- *Data: Using information conveyed as data, graphs, and charts; drawing inferences from data; recognizing disaggregation as a fac- tor in interpreting data.*
- *Computers: Using spreadsheets, recording data, performing calcula- tions, creating graphic displays, extrapolating, fitting lines or curves to data.*
- *Modeling: Formulating problems, seeking patterns, and drawing conclusions; recognizing interactions in complex systems; under- standing linear, exponential, multivariate, and simulation models; understanding the impact of different rates of growth.*
- *Statistics: Understanding the importance of variability; recognizing the differences between correlation and causation, between randomized experiments and observational studies, between finding no effect and finding no statistically significant effect (especially with small samples), and between statistical significance and practical importance (especially with large samples).*
- *Chance: Recognizing that seemingly improbable coincidences are not uncommon; evaluating risks from available evidence; under- standing the value of random samples.*
- *Reasoning: Using logical thinking; recognizing levels of rigor in methods of inference; checking hypotheses; exercising caution in making generalizations.*

Resources

1. ASCSU Task Force on Quantitative Reasoning Report (September 1, 2016)

The Task Force proposes this general definition for quantitative reasoning:
The ability to reason quantitatively is a stable combination of skills and practices involving:

I. the ability to read, comprehend, interpret, and communicate quantitative information in various contexts in a variety of formats;
II. the ability to reason with and make inferences from quantitative information in order to solve problems arising in personal, civic, and professional contexts;
III. the ability to use quantitative methods to assess the reasonableness of proposed solutions to quantitative problems; and
IV. the ability to recognize the limits of quantitative methods.

Quantitative reasoning depends on the methods of computation, logic, mathematics, and statistics.
The full report may be found at https://drive.google.com/drive/u/0/folders/0B53rQbvz8N3bR0J4Q0p0bzBYNnM

2. The Case for Quantitative Literacy
https://drive.google.com/file/d/0B53rQbvz8N3bNFFUdDFBTl9VN2c/view

3. Different Views on Quantitative Literacy
https://www.stolaf.edu/other/extend/Numeracy/defns.html
A collection of definitions and descriptions of quantitative literacy.

3. Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education
https://drive.google.com/open?id=0B4BXlM4LT-1NTWxTNEdGNTZ3RDQ

A collection of essays on quantitative literacy, compiled by the Mathematical Association of America

4. Quantitative Reasoning for College Graduates: A Complement to the Standards http://www.maa.org/programs/faculty-and-departments/curriculum-department-guidelines-recommendations/quantitative-literacy/quantitative-reasoning-college-graduates#Intro

5. Quantitative Reasoning: An Overview
http://www.uwyo.edu/smtc/_files/docs/projects/qr%20stem/qr%20resources/quantitative%20reasoning%20an%20overview.htm