



Carnegie Foundation for the Advancement of Teaching

Quantway® Pathway

INSTRUCTIONAL SYSTEM

- *Ambitious learning goals* leading to deep and long lasting understanding;
- *Lessons and out-of-class materials* to advance these goals;
- *Formative and summative assessments*, including end of module and end of course assessments;
- *Productive Persistence* - an evidence-based package of student activities and faculty actions developed from promising psychological research and expert practitioner knowledge integrated throughout the instructional system to increase student motivation, tenacity and skills for success;
- *Language and literacy* component which interweaves necessary supports in instructional materials and classroom activities so that learning is accessible to all;
- *Advancing Quality Teaching* component to provide instructors with the knowledge, skills, and habits necessary to experience efficacy in initial use and develop increasing expertise over time. This dimension is essential in seeking to reduce the variability in outcomes; and
- *Analytics to support the continuous improvement of teaching and of the materials.*

CARNEGIE COMMITTEE FOR QUANTITATIVE REASONING OUTCOMES (CCQRLO)

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The following goals and learning outcomes have been chosen by the committee to enable students to achieve this overarching vision of what it means to have quantitative literacy.

STUDENT LEARNING OUTCOMES

Quantitative with Multiple Literacies Goal: Students will develop their quantitative reasoning abilities through learning and practicing other essential literacies and reasoning skills. In particular, students will practice and make explicit connections with the following reasoning skills and literacies:

- L.1 Quantitative Literacy:** Students will demonstrate the Quantitative Literacy “habit of mind.” In particular, students will:
- L.1.1 Demonstrate an **appreciation for QL** by reading about and discussing the importance of QL in the world both globally and in their lives.
 - L.1.2 Show confidence in quantitative reasoning through **perseverance** in quantitative thinking and ability to **transfer** prior knowledge from one context to the next.
 - L.1.3 **Check the reasonableness** of quantities that have been presented to them or numbers that they calculate or estimate.
 - L.1.2 Use correct **units** when using numbers based on the context.
- L.2 Critical Reading:** Students will be able to read and interpret quantitative information from a variety of real-world sources. Students will be able to recognize and evaluate quantitative assumptions.
- L.3 Communication:** Students will communicate quantitative results by
- L.3.1 Writing and orally presenting their work using appropriate language, symbolism, data and graphs.
 - L.3.2 Analyzing and using quantitative information to support an argument.
- L.4 Information Literacy:** Students will be develop critically thinking skills about quantitative information by
- L.4.1 Evaluating sources of information.
 - L.4.2 Locating reliable and appropriate quantitative data
- L.5 Visual/Graphical Literacy:** Students will be able to read, interpret, and make decisions based on visual displays of quantitative information including line graphs, bar graphs, scatter plots, histograms, and maps with multiple parameters.
- L.6 Technology Literacy:** Students will be able to use technology appropriately as a tool including
- L.6.1 Knowing when and how to use calculators appropriately.
 - L.6.2 Using computers and the Internet to gather, research and analyze quantitative information.

- L.6.3 Questioning and evaluating the output from a computer application.
- L.6.4 Using spreadsheets to create and/or investigate mathematical models whenever possible.
- L.6.5 Facility with other appropriate technologies wherever possible. These technologies could include data software packages, math or statistical applications on smartphones, or java applets.

L.7 Spatial/Geometric Reasoning: Students will be able to apply spatial reasoning to solve geometric problems involving area, perimeter, and volume of basic shapes including using and translating between different units of measurement.

Numeracy Skills Goal: Students will develop and apply the concepts of numeracy to investigate and describe quantitative relationships and solve problems in a variety of contexts. Students will be able to:

- N.1** Demonstrate **operation sense** and communicate verbally and symbolically the effects of common operations on numbers.
- N.2** Demonstrate an understanding of and competency in using **magnitude** in the context of place values, fractions, and numbers written in scientific notation.
- N.3** Use **estimation skills**, knowing how and when to estimate results and to what precision, to solve problems, detect errors, and check accuracy.
- N.4** Demonstrate **measurement sense** including units, precision, accuracy and error.
- N.5** Be able to use and distinguish between statements involving **absolute change and relative change**.
- N.6** Be able to use and interpret **percentages** in a variety of contexts including but not limited to: Parts to whole comparisons, decimal representations of percentages, quantifying risks and other probabilities, rates, change, and margins of error.

Proportional Reasoning Goal: Students will represent proportional relationships and solve problems that require an understanding of ratios, rates, proportions, and scaling. Students will be able to:

- P.1** Recognize **proportional relationships** from verbal and numeric representations.
- P.2** Compare **proportional relationships** represented in different ways.

- P.3** Apply quantitative reasoning strategies to **solve real-world problems with proportional relationships** based on an understanding that derived quantities can be described with whole numbers, fractions, or decimals, or in a combination of these, and that to fully explain these relationships, units must be used.

Algebraic Reasoning Goal: Students will reason using the language and structure of algebra to investigate, represent, and solve problems.

- A.1** Understand various **uses of variables** to represent quantities or attributes.
- A.2** Describe the **effect that a change in the value of one variable** has on the value(s) of other variables in the algebraic relationship.
- A.3** **Construct and use equations** to represent relationships involving one or more unknown or variable quantities to solve problems.

Mathematical Modeling Goal: Students will reason using the language and structure of mathematics to investigate, represent, and solve problems. Students will be able to:

- M.1** Create **models** of authentic contextual situations, including
- M.1.1 Using multiple representations of mathematical models such as tables, graphs, equations, and words;
 - M.1.2 Using multiple variables to represent quantities or attributes;
 - M.1.3 Describing why these tools are a useful strategy for understanding the world; and
 - M.1.4 Describing limitations present in these models.
- M.2** Demonstrate an extensive understanding of **linear** models by
- M.2.1 Creating and using linear models of real world situations.
 - M.2.2 Describing the behavior of linear models using words, algebraic symbols, graphs, and tables.
 - M.2.3 Identifying when a linear model or trend is reasonable for given data or context.
 - M.2.4 Determining a reasonable domain of the model based on the scenario.
 - M.2.5 Use appropriate terms and units to describe rate of change. (For example: Describe the rate of change using appropriate units: slope for linear relationships or average rate of change over an interval for nonlinear relationships.)
- M.3** Demonstrate an understanding of **exponential** models by
- M.3.1 Creating and using exponential models of real world situations including growth and decay models beyond financial concepts.
 - M.3.2 Describing the behavior of exponential models using words, algebraic symbols, graphs, and tables.

- M.3.3 Identifying when an exponential model or trend is reasonable for given data or context.
- M.3.4 Determining a reasonable domain of the model based on the scenario.

M.4 Develop mathematical modeling skills in personal **finance** that move beyond basic exponential models.

M.5 Understand and describe **models beyond linear and exponential models**. Students will be able to:

- M.5.1 Identify when a linear and/or exponential model is not reasonable
- M.5.2 Identify important characteristics of models (e.g. increasing/decreasing, cyclic, piecewise, etc.) that represent real world contexts
- M.5.3 Identify multiple parameters in a scenario.

M.6 Identify important characteristics of models in various representations.

M.7 Understand that abstract mathematical models used to characterize real-world scenarios or physical **relationships are not always exact and may be subject to error** from many sources, including variability.

Statistical Thinking Goal: Students will reason using the language and structure of statistics to investigate, represent, and solve problems. Students will be able to:

S1. Critically **evaluate statistics** being presented in a media report including

- Identifying the reference value for a reported percentage
- Evaluating the sampling strategy
- Determining sources of bias
- Describing the difference between correlation and causation
- Identifying confounding variables

S2. Use the language of **probability** to describe and evaluate statements involving risk.

S3. Calculate and interpret **measures of center** including mean, median, expected value, and weighted average.

S4. Use and interpret **measures of spread** including standard deviation, quartiles, percentiles, and range.