

## EMPIRICAL AND QUANTITATIVE SKILLS TOOLBOX

This toolbox provides a brief but thorough collection of resources pertaining to Core Curriculum assessment. This toolbox does not replace conversations about Core Curriculum assessment; it is provided so that all instructors can quickly and easily access this information. This toolbox will be continuously updated to insert, remove, and otherwise revise information when necessary.

### **Empirical & Quantitative Skills Assessment Overview**

Student demonstration of empirical skills and quantitative skills often includes: (1) understanding mathematical forms; (2) using relevant information to make accurate mathematical representations; (3) successfully completing calculations in an organized manner; and (4) making judgments and drawing conclusions from the analysis of mathematical data.

Students may demonstrate empirical skills and quantitative skills in many contexts, such as through interpreting the output of a discipline-specific quantitative operation or through correctly interpreting quantitative data from common documents (i.e., bills or budgets). Students may also produce their own calculations in response to applied issues.

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### **On the following pages, you will find....**

- **Empirical & Quantitative Skills rubric (pg. 2)**
  - The rubric featured in this toolbox is the most up-to-date version of the rubric that will be used to assess Core Curriculum artifacts on Empirical & Quantitative Skills.
- **Empirical & Quantitative Skills assignment strategies (pg. 3)**
  - This page features descriptions and examples of assignments that align well with the rubric.
- **Empirical & Quantitative Skills resources for faculty (pg. 4)**
  - This page includes peer-reviewed journal articles, modules, handbooks, and/or other resources focused on teaching and strategies faculty can use to develop students' empirical skills and quantitative reasoning skills.
- **Empirical & Quantitative Skills resources for students (pg. 5)**
  - This page contains links to additional educational materials, refreshers, practice problems, and other materials students can use to further develop empirical and quantitative skills.

## EMPIRICAL AND QUANTITATIVE SKILLS RUBRIC

	Capstone	Milestones		Benchmark	Below Benchmark	Section Score
	4	3	2	1	0	
<b>Interpretation</b> <i>Ability to explain information presented quantitatively (e.g., equations, graphs, diagrams, tables, words)</i>	Provide accurate explanations of information presented quantitatively. Makes appropriate inferences based on that information. <i>For example, accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest about future events.</i>	Provides accurate explanations of information presented quantitatively. <i>For instance, accurately explains this trend data shown in a graph.</i>	Provides somewhat accurate explanations of information presented quantitatively, but occasionally makes minor errors related to computations or units. <i>For instance, accurately explains trend data shown in a graph, but may miscalculate the slope of the trend line.</i>	Attempts to explain information presented quantitatively, but draws incorrect conclusions about what the information means. <i>For example, attempts to explain the trend data shown in a graph, but will frequently misinterpret the nature of that trend, perhaps by confusing positive and negative trends.</i>	Failed to meet benchmark.	
<b>Representation</b> <i>Ability to convert relevant information quantitatively (e.g., equations, graphs, diagrams, tables, words)</i>	Skillfully converts relevant information into a quantitative representation in a way that contributes to a deeper understanding.	Competently converts relevant information into an appropriate and accurate quantitative representation.	Completes conversion of information but resulting quantitative representation is only partially appropriate or accurate.	Completes conversion of information but resulting quantitative representation is inappropriate or inaccurate.	Failed to meet benchmark.	
<b>Calculation</b>	Calculations attempted are all correct and sufficiently comprehensive to solve the problem. Calculations are also presented elegantly (clearly, concisely, etc.)	Calculations attempted are mostly correct and sufficiently comprehensive to solve the problem.	Calculations attempted are either incorrect or represent only a portion of the calculations required to comprehensively solve the problem.	Calculations are attempted but are both incorrect and are not comprehensive.	Failed to meet benchmark.	
<b>Analysis</b> <i>Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis</i>	Uses the quantitative analysis of data as the basis for deep and thoughtful judgments, drawing, insightful, carefully qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for simplistic (without inspiration or nuance, ordinary) judgments, drawing plausible conclusions from this work.	Uses the quantitative analysis of data as the basis for tentative, basic judgments, although is hesitant or uncertain about drawing conclusions from this work.	Failed to meet benchmark.	
<b>Communication</b> <i>Expressing quantitative evidence in support of the argument or purpose of the work (in terms of what evidence is used and how it is formatted, presented, and contextualized)</i>	Uses quantitative information in connection with the argument or purpose of the work, and the argument being made is complete AND clear.	Uses quantitative information in connection with the argument or purpose of the work, and the argument being made is complete OR clear.	Uses quantitative information in connection with the argument or purpose of the work, but the argument being made is incomplete not clear.	Presents an argument for which quantitative evidence is pertinent, but the argument is disconnected or barely explains this quantitative evidence.	Failed to meet benchmark.	
<b>TOTAL Score</b>						

Rubric selected and approved in January 2013 by the Core Curriculum sub-committee of the A3C to assess Core artifacts on Empirical & Quantitative Skills.  
Revisions finalized by Academic Assessment Committee in March 2016.

## EXAMPLES OF EMPIRICAL AND QUANTITATIVE SKILLS ASSIGNMENT STRATEGIES

Strategy	Description	Sample assignments, tools, and other resources
<b>Collect and evaluate student interpretations of and responses to data presented in tables, graphs, and other mediums.</b>	Students can be presented with data in tables, graphs, and other discipline-relevant mediums. Students could then be asked to quantitatively corroborate these presentations, interpret the data, and justify these interpretations. A rubric would then be used to evaluate student work.	<ul style="list-style-type: none"> <li>• Copy of an article analysis assignment used to assess empirical and quantitative skills in an economics program (available upon request<sup>1</sup>).</li> </ul>
<b>Collect and evaluate student responses to information that could be empirically examined.</b>	Students can be presented with claims, myths, and other statements, and ask them to use empirical and/or quantitative concepts to confront or justify them. Student work would then be evaluated using a rubric.	<ul style="list-style-type: none"> <li>• Copy of a research journalism assignment used to assess empirical and quantitative skills in a psychology program (available upon request<sup>1</sup>).</li> <li>• Description of a competing claims assignment used in an English program can be found here: <a href="http://tinyurl.com/hqyxpl9">http://tinyurl.com/hqyxpl9</a></li> </ul>
<b>Collect and evaluate student computations and the justifications that accompany each step.</b>	Students can be asked to demonstrate basic skills in algebra, statistics, or arithmetic to solve mathematical problems, and to justify each step (and correctly interpret the end result) to an audience. A rubric can then be used to evaluate student work.	<ul style="list-style-type: none"> <li>• Copy of a field exercise assignment used to assessment empirical and quantitative skills in an ecology course (available upon request<sup>1</sup>).</li> </ul>

<sup>1</sup> Please contact the Academic Assessment Coordinator for these materials. All of these materials will soon be posted on a webpage that is in development.

## EMPIRICAL AND QUANTITATIVE SKILLS RESOURCES FOR FACULTY

Description	Link or instructions to obtain resources
<p><b>Lutsky, N. (2008). Arguing with numbers: A rationale and suggestions for teaching quantitative reasoning through argument and writing. In B. L. Madison &amp; L. A. Steen (Eds.), <i>Calculation vs. Context: Quantitative Literacy and its Implications for Teacher Education</i> (pp. 59-74). Washington, D.C.: Mathematical Association of America.</b></p> <p>This article introduces four propositions related to understanding and teaching quantitative reasoning. This article also includes ten QRs (Questions at the Ready) for students and includes several specific principles and strategies instructors can reference when teaching quantitative reasoning.</p>	<p>This article can be accessed here:  <a href="http://www.maa.org/sites/default/files/pdf/QL/cvc/cvc-059-074.pdf">http://www.maa.org/sites/default/files/pdf/QL/cvc/cvc-059-074.pdf</a></p>
<p>The <b>“Electronic Bookshelf” webpage</b> created by Dartmouth University’s Center for Mathematics and Quantitative Education contains a variety of teaching tools and resources. All content is organized by subject matter and may include teaching activity materials, online modules, and other materials.</p>	<p>This information can be accessed here:  <a href="https://math.dartmouth.edu/~mqed/eBookshelf/">https://math.dartmouth.edu/~mqed/eBookshelf/</a></p>
<p>The <b>“Best Practices for Quantitative Reasoning Instruction” webpage</b> created by the City University of New York (CUNY) Quantitative Reasoning Alliance’s Numeracy Infusion Course for Higher Education (NICHE) contains information on: (1) “real world” applications and active learning; (2) pairing QR instruction with writing and critical thinking; (3) use of technology; (4) collaborative instruction and group work; (5) differences in culture and learning preferences; and (6) scaffolding, feedback, and use of revision opportunities.</p>	<p>This information can be accessed here:  <a href="http://serc.carleton.edu/NICHE/best_practices.html">http://serc.carleton.edu/NICHE/best_practices.html</a></p>
<p>The <b>“Curricular Materials” webpage</b> created by Carleton University’s Quantitative Inquiry, Reasoning, and Knowledge (QuIRK) initiative heavily focuses on writing-oriented approaches to teaching quantitative reasoning competencies. This page provides guides for creating QR writing assignments, provides example assignments for instructors to reference, and provides tips on teaching QR across the curriculum.</p>	<p>These materials can be accessed here:  <a href="http://www.go.carleton.edu/quirk/curricular/">http://www.go.carleton.edu/quirk/curricular/</a></p>

## EMPIRICAL AND QUANTITATIVE SKILLS RESOURCES FOR STUDENTS

Description	Link or instructions to obtain resources
The “ <b>Quantitative Resources</b> ” webpage created by the University of Washington-Tacoma’s Teaching and Learning Center contains refresher tools and other materials on mathematics, science, statistics, economics, and other quantitative topics.	These materials can be accessed here: <a href="https://www.tacoma.uw.edu/teaching-learning-center/quantitative-resources">https://www.tacoma.uw.edu/teaching-learning-center/quantitative-resources</a>
The “ <b>Math Refreshers</b> ” webpage created by the University of Washington-Bothell’s Quantitative Skills Center contains refreshers, review sheets, and practice problems/solutions focused on a variety of math topics.	These materials can be accessed here: <a href="http://www.uwb.edu/qsc/resources/refreshers/math-refreshers">http://www.uwb.edu/qsc/resources/refreshers/math-refreshers</a>
<b>Andy Field’s “Statistics Hell”</b> webpage contains a variety of resources focused on introductory, intermediate, and advanced statistics topics.	This information can be accessed here: <a href="http://www.statisticshell.com/html/apf.html">http://www.statisticshell.com/html/apf.html</a>
The “ <b>Statistics Refreshers</b> ” webpage created by the University of Washington-Bothell’s Quantitative Skills Center contains refreshers, review sheets, and practice problems/solutions focused on a variety of topics in statistics.	These materials can be accessed here: <a href="http://www.uwb.edu/qsc/resources/refreshers/statistics">http://www.uwb.edu/qsc/resources/refreshers/statistics</a>