**Quantitative Reasoning**

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**Quality Enhancement Plan Concept Paper: Quantitative Reasoning**

*Quantitative reasoning.* Quantitative reasoning (QR)—also known as Quantitative Literacy (QL) or Numeracy—is defined as the ability to reason and solve quantitative problems and make precise and accurate arguments using numerical values (Karaali, Hernandez, & Taylor, 2016). QR skills are important for university students to succeed in the classroom and in their careers. Virtually all careers require basic QR skills such as completing estimations, calculating values, and most importantly, interpreting data. Additionally, college graduates in specialized fields are required to possess high-level QR skills (AAC&U, 2010). A national survey of businesses and nonprofit leaders conducted by Hart Research Associates for the Association of American Colleges & Universities (AAC&U) found that employers in all fields expect graduates to possess QR skills upon entry into the workforce (Hart Research Associates, 2015, p. 13). Our students count on us to teach them these skills necessary for their success. However, according to the Educational Testing Service (ETS), students at Texas A&M University – Central Texas (A&M – Central Texas) need to improve QR skills. Therefore, it is imperative that A&M – Central Texas adopt a Quality Enhancement Plan (QEP) that addresses this deficiency and spotlights QR.

**Supporting the University Mission with Quantitative Reasoning and High Impact Practices**

Our faculty and staff can better fulfill the university’s mission by adopting QR High Impact Practices (HIPs) to provide a more quintessential educational experience. Our mission promises that A&M – Central Texas will provide “high quality, rigorous, and innovative learning experiences” and that our faculty and staff will demonstrate “excellence in teaching, service, and scholarship”. HIPs are innovative teaching techniques that improve education by fostering student engagement and learning through meaningful interactions with the goal of providing an educational experience more relevant to the personal and professional lives of students. Susan Elrod (2014), the Provost and Executive Vice Chancellor for Academic Affairs at the University of Wisconsin and QR advocate, argues in AAC&U’s journal *peerReview*, that QR is relevant to people’s lives more than just in their careers. People need to analyze data, much of which is quantitative in nature,
and interpret that data to make everyday decisions. QR is therefore central to the mathematical and critical thinking skills that those decisions demand (pg. 1). We have the opportunity to distinguish ourselves from other institutions by implementing QR HIPs in our curriculum to demonstrate our dedication to our mission and the personal and professional development of our students.

Identifying High Impact Practices

Not all HIPs will benefit our students, because A&M – Central Texas has a non-traditional student population. A&M – Central Texas is one of only four upper-division universities in the United States that offer only upper-level and graduate classes. Typically, undergraduate students begin our programs after completing core curriculum or obtaining an Associate degree. Therefore, HIPs that reform core curriculum or target lower level courses, such as Common Intellectual Experiences and Freshman Seminars, are impractical for our purpose. Also, the student population at A&M – Central Texas has the highest average age for bachelor’s graduates of all the public universities in Texas at the age of 33 while the statewide average is 25 (Schneider, 2013, pg. 50). A significant reason for this unusual sampling is because A&M – Central Texas is located near Fort Hood, one of the military’s largest and most populated military installations, and our student body reflects the military population in the region. Also, many of our students are more established in their lives and careers than students at more traditional universities, and they must fit their class schedules between family and work. Our uniformed students and students from military families face additional barriers such as unplanned military duties, extended deployments, and changes of duty stations.

HIPs implemented at A&M – Central Texas should possess specific attributes that best serve the unique needs of our students. First, HIPs should be egalitarian. A&M – Central Texas cannot target early or core class. Therefore, University leaders should seek HIPs that are implementable across all departments or risk overlooking some students. This can be accomplished with HIPs that target key classes within programs or with HIPs that are accessible to all students regardless of discipline. Next, HIPs should be practical to both the departments and the students alike. HIPs should require the least bureaucracy to support since all departments do not have access to the same financial or personnel resources. Likewise, HIPs should also respect the time and resources of our students without adding additional personal sacrifice. Lastly, HIPs should be relevant to both the future careers of our students and educational goals of the university. Based on these attributes, Writing Intensive Courses, Collaborative Assignments/Projects, Learning Communities, Undergraduate Research Projects, Internships, and Service/Community-based Learning are identified as HIPs that can potentially have the greatest impact on student success at A&M – Central Texas.
**Writing Intensive Courses.** Writing Intensive Courses can be an effective HIP for strengthening QR skills in students if QR is a significant component. Typically, in a writing intensive course, faculty use research and writing as the primary approach to achieve learning goals. Writing Intensive Courses have long been accepted as a way to enhance student learning and professional development, but lately, universities have used Writing Intensive Courses as a HIP to successfully promote QR skills.

**History.** A group of faculty members at Carleton College in Northfield, MN developed QuIRK, a program that promotes QR through Writing Intensive Courses (Grawe & Rutz, 2009, pg. 1; Lutsky, n.d., pg. 59-60; QuIRK: About QuIRK, 2014). The group recognized that writing could be an effective way for strengthening QR skills when QR is used to develop and support arguments. Under the program, faculty initially assess QR writing assignments by using a rubric to grade the use of QR and to generate baseline data. Next, the curriculum is revised and reevaluated at a later time to test the efficacy of the revision. The evaluation/revision cycle is repeated regularly with the goal of improving the effectiveness of QR writing assignments (“QuIRK: About QuIRK”, 2014).

**Benefits.** The QuIRK model is simplistic, and easily reproducible considering that Writing Intensive Courses are commonly practiced at educational institutions throughout the United States. Existing programs could be simply adapted by modifying the goals and utilizing the QuIRK assessment. Also, this HIP does not require students to enroll in any additional program other than the course. After the program was implementation at Carleton College, the program was successfully reproduced at five other universities (“QuIRK: Applying the rubric outside Carleton”, 2014).

**Challenges.** Although this HIP would not require significant reforms at the university level, it would require some faculty members that do not usually assign writing assignments to dramatically alter the way they approach learning objectives. Faculty members will need to address how much of their course they should dedicate to familiarize students with research and writing techniques or preferred writing style. Some faculty members may avoid writing assignments due to the perceived arbitrariness or increased workload associated with grading written assignments; other faculty members may be inexperienced with writing and may find it difficult to coach students with writing and grading their work. Additionally, many students lack effective writing skills, and it would be easy for faculty to become distracted with remedial writing instruction and lose focus of the course’s learning objectives.

**Collaborative Assignments/Projects and Learning Communities.** Collaborative Assignments/Projects are an effective HIP for reinforcing QR skills and supporting professional development using collaborative learning models that mimic real-world environments by requiring students to work
and solve problems collectively (Kuh, O'Donnell, & Reed, 2013). This HIP is very feasible to employ across disciplines requiring universities to adapt only a few key courses, and no special enrollment would be required for the students to participate.

**History.** Caulfield and Hodges (2006) adapted sociology courses to use collaborative groups and found that the majority of participating students were more motivated to work harder and learned more while working in groups (pg. 52). Dingman and Madison (2010) designed a non-major mathematics course affectionately called “News Math” by their students. The course utilized collaborative projects where arts and humanities students read and interpreted data from newspaper articles to broaden QR skills (pg. 1). A major hurdle for developing and strengthening higher level QR skills is math anxiety. Math anxiety is the tension and fear that impedes the ability to face math. When used effectively, Collaborative Assignments/Projects can help reduce math anxiety in students. Grouws and Cebulla (2000), argue that in math courses, “[t]eachers must encourage students to find their own solution methods and give them opportunities to share and compare their solutions methods and answers... have students work in small groups initially and then share ideas and solutions in a whole-class discussion” (pg. 20).

Learning Communities are similar in principle to Collaborative Assignments/Projects but utilize a broader interdisciplinary scope. Unlike Collaborative Assignments/Projects, Learning Communities HIPs are practiced across a block of courses instead of a solitary class. Students from various departments or programs are formed into a group, and the members of the group are jointly enrolled into a block of courses thoughtfully derived from multiple disciplines. This format immerses students and faculty into an interdisciplinary environment, and encourages students and faculty to work together on projects and assignments that require broader, more integrative solutions (Kuh, O'Donnell, & Reed, 2013). This interdisciplinary design has the potential for a larger impact on the QR skills of students than other QR HIPs, because participating students are exposed to QR in a variety of settings through broad research and frequent interaction with faculty and students from other disciplines. Students share their knowledge and experience with others by applying QR concepts from their chosen field of study to other academic fields helping each other and strengthening their own QR skills in the process.

**Benefits.** Reports suggest that Learning Communities have a positive impact on student learning experiences and their implementation have contributed to achieving learning outcomes (“Learning Communities”, n.d.; “Linked Cohort Courses”, n.d.; & “Quantitative Reasoning Assessment”, n.d.). This HIP can be a powerful tool to improve QR skills among students and benefit students, faculty, and the university as a whole. Masterson (1998) states that “learning communities work...learning communities are good for students, who learn subject matter better and form stronger social bonds; good for faculty, who enjoy teaching with their colleagues; and good for the institution overall. Learning improves; satisfaction improves; retention improves” (Masterson, 1998).
Challenges. Although reports claim that the collaborative nature of these HIPs encourage individual students to work harder than they would with independent assignments, these reports contradict numerous studies on social loafing which conclude that the opposite is true. According to Karau and Williams (1993), social loafing is “the tendency for individuals to expend less effort when working collectively than when working individually,” and they argue that social loafing is very common (pg. 681). Faculty members are not blind to social loafing, and they may avoid group assignments altogether leading to inexperience with the challenges of group assignments. Departments will need to provide guidance to these faculty members with policies and mechanisms to prevent social loafing. Additionally, these HIPs would challenge some faculty members to significantly alter their teaching styles or to work collectively with other faculty within Learning Communities.

Undergraduate Research Projects, Internships, and Service/Community-based Learning. Undergraduate Research Projects, Internships, and Service/Community-based Learning are HIPs that could meet the criteria set forth if they are enacted together in a combined strategy. Unlike HIPs implemented across courses or departments, students perform these HIPs independently outside the scope of a course with the exception of Service/Community-based Learning, which has components that occur within a course. Students who participate in these programs benefit substantially by gaining skills and experience desirable to employers, and in some fields, employers even expect their applicants to have these educational experiences.

Undergraduate Research Projects. Undergraduate Research Projects are used extensively in the social and life sciences largely because these disciplines have strong financial support from federal agencies and private organizations that allows faculty to support Undergraduate Research Projects. However, this HIP does not necessarily require substantial funding; disciplines in other fields have long used this HIP, sometimes called independent research studies, with little or no funding.

Internships. Internships forgo the potential problem with funding altogether, because other institutions or businesses administer the majority of functions. Additionally, Internships provide students with relevant work experience, in an actual workplace environment, as they work alongside industry professionals—something universities cannot replicate. Specifically, students will learn the QR skills required by employers in their field.

Service/Community-based Learning. Service/Community-based Learning is similar to Undergraduate Research Projects in that they are performed independently and promote interpersonal skills. This HIP is also similar to Internships, because they have a significant off-campus component and provide students with unique experiences. However, the research in Service/Community-based Learning projects occurs within the context of a course and then later shared
with the community with the goal of providing a community service. In the end, students report back to the classroom to reflect on their personal experiences with the project. Service/Community-based Learning projects are much smaller in scope than Undergraduate Research Projects or Internships, and they may not have the same educational impact as other HIPs. However, the students have the potential to participate in more than one Service/Community-based Learning project for a richer learning experience, and depending on the nature of the projects, the students can apply and strengthen an array of QR skills.

**Challenges.** These HIPs will be challenging to enact. The most significant challenge is that individually these HIPs do not possess the attributes that would best serve our students and would need to be enacted together through a combined strategy to meet our criteria. Furthermore, the available data may not be relevant since we are an upper-level institution. Essentially, this would be a new approach that would require original solutions. Additionally, some departments will have problems with the manpower needed to support individual undergraduate research projects that occur outside the scope of a course. Also, universities and departments would be required to form relationships with other businesses and institutions to introduce internships, and some internship opportunities will not be available to all students. Lastly, departments and faculty may find it difficult to adapt Service/Community-based Learning to their discipline, and this HIP may not be relevant to some disciplines.

**Learning Outcomes**

When implementing QR HIPs, it is recommended that A&M – Central Texas adapt the QR learning outcomes published by the Mathematical Association of America (MMA), the world’s leading mathematical society, in a report titled, “Quantitative Reasoning for College Graduates” (Bernhardt, et.al., 1994). These learning outcomes have been widely adapted by universities for use in QR competency initiatives, including the QuIRK program at Carleton College (Quantitative Reasoning, 2012; Quantitative Reasoning, 2014). The report argues that the following list of learning outcomes are the basic QR skills that all college graduates should possess to solve the real-world problems expected of them:

- Interpret mathematical models and formulas, graphs, table, and schematics, and draw inferences from them.
- Represent mathematical information symbolically, visually, numerically, and verbally.
- Use arithmetical, algebraic, geometric, and statistical methods to solve problems.
- Estimate and check answers to mathematical problems in order to determine reasonableness, identify alternatives, and select optimal results.
• Recognize that mathematical and statistical methods have limits.

Challenges with Assessments

The most challenging aspect of implementing QR HIPs is the lack of developed assessments available to universities. The broad consensus among QR experts is that it is extremely difficult, if not impossible, to create an objective standard for evaluating the weight of quantitative arguments. Elrod (2014) explains, “[i]t is less about how to perform the calculation and more about the meaning of the calculation results” (pg. 5). While developing the VALUE rubric for QR, the AAC&U notes that “[i]t’s possible to find pages of mathematical problems, but what those problem sets don’t demonstrate is whether the student was able to think about and understand the meaning of [the] work”. Steen (2004), another leading QR expert, argues that “[QR] requires creativity in assessment, since neither course grades, nor test scores provide a reliable surrogate” (pg. 16).

MMA assessment guidelines. Despite this challenge, it is imperative for universities to develop an appropriate assessment to evaluate QR, and the MMA recommends that universities create assessments that have the following traits (Bernhardt, et.al., 1994):

• be sensitive to reality
• be based on what is understood about how students learn
• fit the nature of the type of assignment
• reflect the type of learning that is being measured
• be an integral part of the teaching-learning process
• reflect the interdisciplinary nature of the assignment
• provide students the opportunity to demonstrate their QR competency in a variety of ways.

QuIRK assessment. It may not be necessary to create an assessment de novo. The QuIRK assessment developed by Grawe and colleagues (2010) could be modified for assessing individual QR assignments (Grawe, Lutsky, & Tassava, 2010) (see Appendix I). This assessment is composed of two parts—a questionnaire and a rubric, and they are used together to evaluate the overall quality of QR utilizing a total of nine grades. First, the questionnaire is used to evaluate the quality of a QR assignment by categorizing it into one of three preliminary grades: “centrally relevant,” “peripherally relevant,” or “irrelevant.” Next, if the assignment is not graded “irrelevant,” the rubric is used to further refine the evaluation into four “centrally relevant” or “peripherally relevant” sub-grades. This assessment is intended to be used to grade samples of written assignments to test
the effectiveness of the QuIRK program. However, it can be used to assess effectiveness of QR writing assignments.

AAC&U VALUE rubric. However, the most promising assessment is the Quantitative Literacy VALUE rubric created by the AAC&U to assist universities in assessing and improving their own QR initiatives (see Appendix II). Like the QuIRK assessment, this rubric was intended for use on samples of QR assignments to evaluate a program, but it could also be modified to assess individual QR assignments. The rubric assesses QR using six criteria: interpretation, representation, calculation, application/analysis, assumptions, and communication. The rubric could be very effective for grading QR assignments, because the rubric describes each of the criteria in detail and provides a robust performance rating system to score each of the criteria, ranging from the highest level of QR competency ‘capstone’ (4) through mid-range ‘milestones’ (3, 2), to beginner level (1) (AAC&U, 2010).

Conclusion

Many educational institutions are aware that QR is a serious problem, but very little is done to manage it. Faculty may be hesitant to incorporate QR due to the perception that solutions would require burdensome assessments, stifling oversight, or heavier workloads (Bernhardt, et.al., 1994). However, Elrod (2014) contends that QR only needs to be included as a component of existing assessments and practices (pg. 10). This is true at A&M — Central Texas. All of the HIPs discussed are already utilized to some degree to address other learning areas. University leaders should encourage faculty to integrate QR into existing HIPs, or to design new HIPs with QR components if none are utilized. However, faculty are not immune to math anxiety, and engaging QR may seem intimidating due to the challenges of defining QR and assessing it objectively. Nonetheless, it does not take a mathematician to effectively assess QR. Virtually all faculty can identify QR and judge its meaningfulness without hesitation, but the university could assist faculty with training, guidance, and a comprehensive rubric like the AAC&U VALUE rubric. Therefore, A&M — Central Texas needs to seize this opportunity to pioneer QR initiatives and make this weakness our strength demonstrating that WARRIORS do not succumb to fear.
References


Dingman, S.W. & Madison, B.L. (2010). Quantitative reasoning in the contemporary world, 1: The course and its challenges. Numeracy, 3(2): Article 4. doi: http://dx.doi.org/10.5038/1936-4660.3.2.4


QuIRK: About QuIRK. (2014, May 05). Retrieved from https://apps.carleton.edu/quirk/about/


capital punishment—with an argument that cries out for quantitative analysis while another student chooses a response involving no QR aspect.

<table>
<thead>
<tr>
<th>Quantitative Reasoning in Student Writing Rating Sheet</th>
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<tbody>
<tr>
<td>I. Identification. Student ID. #: _________________ Reader ID. #: ___</td>
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<tr>
<td>II. Is QR potentially relevant to this paper? (rate potential context of paper, not the assignment)</td>
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<tr>
<td>____ NO or incidentally only ____ YES, but peripherally only ____ YES, centrally</td>
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<tr>
<td>III. What is the extent of numerical evidence and quantitative reasoning present in the paper? [See “Employs QR Criteria” Note: This is not a rating of the quality of the QR shown; only in presence]</td>
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<tr>
<td>_____ rating of 1-3, review attached criteria</td>
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<tr>
<td>IV. OVERALL ASSESSMENT of Quality of implementation, interpretation, and communication of QR:</td>
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<tr>
<td>_____ rating of 1-4, review attached criteria</td>
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<tr>
<td>V. Problematic characteristics of the QR present in the paper [check all issues that detract significantly from the reader’s understanding of the information presented]</td>
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<tr>
<td>____ Uses ambiguous words rather than numbers.</td>
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<td>____ Fails to provide numbers that would contextualize the argument.</td>
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<td>____ Fails to describe own or others’ data collection methods.</td>
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<tr>
<td>____ Doesn’t evaluate source or methods credibility and limitations.</td>
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<td>____ Inadequate scholarship on the origins of quantitative information cited.</td>
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<td>____ Makes an unsupported claim about the causal meaning of findings.</td>
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<tr>
<td>____ Presents numbers without comparisons that might give them meaning.</td>
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<tr>
<td>____ Presents numbers but doesn’t weave them into a coherent argument.</td>
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<tr>
<td>VI. Does the assignment explicitly call for the use of QR in the paper?</td>
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<td>____ YES ____ NO ____ NO ASSIGNMENT PRESENT</td>
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Figure 1. Scoring rubric.

The rubric allows three possible responses: No relevance, peripheral relevance, and central relevance. Examples of papers which likely fall in the first category might include an examination of the role of Confucianism in the downfall of the Han dynasty or a comparison of the depictions of Lucretia in paintings by Rembrandt and Gentileschi.

Our past reading of student work suggests that papers for which QR is relevant can actually involve quantitative evidence in either a central or a
scale of 1 to 4. In high-scoring papers, the use of QR enhances the effectiveness of the paper, advancing the argument. By contrast, in low-scoring papers, the ineffectiveness or absence of QR substantially weakens the argument.

Table 1. Rubric Language for Assessing Quality of QR

<table>
<thead>
<tr>
<th>Quality Score</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td><strong>A. In Papers where QR is Centrally Relevant</strong></td>
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</tr>
<tr>
<td>Use of numerical evidence is so poor that either it is impossible to evaluate the argument with the information presented or the argument is clearly fallacious. Perhaps key aspects of data collection methods are missing or critical aspects of data source credibility are left unexplored. The argument may exhibit glaring misinterpretation (for instance, deep confusion of correlation and causation). Numbers may be presented, but are not woven into the argument.</td>
<td>The use of numerical evidence is sufficient to allow the reader to follow the argument. But there may be times when information is missing or misused. Perhaps the use of numerical evidence itself is uneven. Or the data are presented effectively, but a lack of discussion of source credibility or methods makes a full evaluation of the argument impossible. Misinterpretations such as the confusion of correlation and causation may appear, but not in a way that fundamentally undermines the entire argument.</td>
<td>The use of numerical evidence is good throughout the argument. Only occasionally (and never in a manner that substantially undermines the credibility of the argument) does the paper fail to explore source credibility or explain methods when needed. While there may be small, nuanced errors in the interpretation, the use of numerical evidence is generally sound. However, the paper may not explore all possible aspects of that evidence.</td>
<td>The use of numerical evidence is consistently of the highest quality. When appropriate, source credibility is fully explored and methods are completely explained. Interpretation of the numerical evidence is complete, considering all available information. There are no errors such as confusion of correlation and causation. This paper would be an excellent choice as an example of effective central QR to be shared with students and faculty.</td>
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| **B. In Papers where QR is Peripherally Relevant** | | | | |
| Fails to use any explicit numerical evidence to provide context. The paper is weaker as a result. This paper shows no attempt to employ peripheral QR. | Uses numerical evidence to provide context in some places, but not in others. The missing context weakens the overall paper. Or the paper may consistently provide data to frame the argument, but fail to put that data in context by citing other numbers for comparison. Ultimately, the attempt at peripheral use of QR does not achieve its goal. | The paper consistently provides numerical evidence to contextualize the argument when appropriate. Moreover, numbers are presented with comparisons (when needed) to give them meaning. However, there may be times when a better number could have been chosen or more could have been done with a given figure. In total, the peripheral use of QR effectively frames or motivates the argument. | Throughout the paper, numerical evidence is used to frame the argument in an insightful and effective way. When needed, comparisons are provided to put numbers in context. This paper would be an excellent choice as an example of effective peripheral QR to be shared with students and faculty. |

Because expectations for QR differ by whether the use (or missed use) was central or only peripheral to the argument, we provide distinct scoring language.
# Quantitative Literacy VALUE Rubric

*For more information, please contact value@asu.edu*

## Definition

Quantitative Literacy (QL) – also known as Numeracy or Quantitative Reasoning (QR) – is a "habit of mind," competency, and comfort in working with numerical data. Individuals with strong QL skills possess the ability to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations. They understand and can create sophisticated arguments supported by quantitative evidence and they can clearly communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, etc., as appropriate).

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (full or) least performance.

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>Capstone 1</th>
<th>Milestone 2</th>
<th>Benchmark 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to convey information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words)</td>
<td>Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information. For example, accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest about future events.</td>
<td>Provides accurate explanations of information presented in mathematical forms. For instance, accurately explains the trend data shown in a graph.</td>
<td>Attempts to explain information presented in mathematical forms, but draws incorrect conclusions about what the information means. For example, attempts to explain the trend data shown in a graph, but sketches the wrong conclusion about the trend, perhaps by confusing positive and negative trends.</td>
</tr>
<tr>
<td>Representation</td>
<td>Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a further or deeper understanding.</td>
<td>Competently converts relevant information into an appropriate and desired mathematical portrayal.</td>
<td>Completes conversion of information but resulting mathematical portrayal is only partially appropriate or accurate.</td>
</tr>
<tr>
<td>Calculation</td>
<td>Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.</td>
<td>Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.</td>
<td>Calculations are attempted but are both unsuccessful and not comprehensive.</td>
</tr>
<tr>
<td>Application/Analysis</td>
<td>Uses the quantitative analysis of data as the basis for deep and thoughtful judgments, drawing insightful, carefully qualified conclusions from this work.</td>
<td>Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable, and appropriately qualified conclusions from this work.</td>
<td>Uses the quantitative analysis of data as the basis for tentative, basic judgments, although it hesitates or uncertain about drawing conclusions from this work.</td>
</tr>
<tr>
<td>Assumptions</td>
<td>Explicitly describes assumptions and provides compelling rationale for why such assumptions are appropriate.</td>
<td>Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.</td>
<td>Attempts to describe assumptions.</td>
</tr>
<tr>
<td>Communication</td>
<td>Uses quantitative information in connection with the argument or purpose of the work, making its contribution clear.</td>
<td>Uses quantitative information in connection with the argument or purpose of the work, though data may be presented in a less than completely effective format or some parts of the explanation may be unclear.</td>
<td>Uses quantitative information, but does not effectively connect it to the argument or purpose of the work. Present an argument for which quantitative evidence is pertinent, but does not provide adequate explicit numerical support. (May use quasi-quantitative words such as &quot;many,&quot; &quot;few,&quot; &quot;increasing,&quot; &quot;small,&quot; and the like in place of actual quantities.)</td>
</tr>
</tbody>
</table>