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| **CSU East Bay ILO Quantitative Reasoning Rubric: Approved by Academic Senate March 19, 2019** Description: Quantitative Reasoning (QR) is competency and comfort in working with numerical data. It involves understanding and applying mathematics/statistics to analyze and interpret real-world quantitative information in a disciplinary context. Individuals with strong QR skills possess the ability to reason about and solve quantitative problems from a wide array of contexts. They understand and can create sophisticated arguments and conclusions supported by quantitative evidence and can clearly communicate those in a variety of formats (using words, tables, graphs, mathematical equations, etc., as appropriate). |
|  | **4** | **3** | **2** | **1** |
| **Problem Formulation**Translation of the disciplinary/real-world problem into a QR context (e.g., writing a hypothesis, a math model, quantitative instrumentation).Use and interpretation of quantitative data/information to identify or formulate a problem. | Formulation of the problem is comprehensive and placed in an appropriate quantitative context.  | Formulation of the problem is adequate and placed in an appropriate quantitative context. | Formulation of the problem is limited; explanation of the context is somewhat incorrect or incomplete. | Formulation of the problem is incorrect or missing; explanation of the context is incorrect or incomplete. |
| **Representation/Visualization**Depiction of quantitative information such as visual (e.g., figures, charts, tables, equations) and non-visual (e.g., audio, ADA accessible). | Accurate and appropriate display of quantitative information using academic vocabulary with correct symbols, units, scale, etc. | Mostly accurate and appropriate display of quantitative information. May contain minor errors in academic vocabulary, symbols, units, scale, etc. | Somewhat accurate and/or appropriate display of quantitative information. May contain major errors in academic vocabulary, symbols, units, scale, etc. | Inaccurate, inappropriate, or missing display of quantitative information. May contain major errors in academic vocabulary, symbols, units, scale, etc. |
| **Quantitative Analysis**Selection and use of analytical methods (e.g., data analysis, solution technique). | Appropriate and accurate selection and use of analytic methods.  | Mostly appropriate and accurate selection and use of analytic methods. | Somewhat appropriate and/or somewhat accurate selection and use of analytic methods. | Inappropriate and inaccurate selection and use of analytic methods. |

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| **Interpretation**Description of the meaning of the results in the context of the original problem formulation. | Appropriate and comprehensive explanation of the results obtained from the quantitative analysis in the context of the original problem. | Mostly appropriate explanation of the results obtained from the quantitative analysis in the context of the original problem. | Somewhat appropriate explanation of the results obtained from the quantitative analysis. Explanation of the context is somewhat incorrect or incomplete. | Inappropriate, inadequate, or missing explanation of the results obtained from the quantitative analysis. Explanation of the context is incorrect or incomplete. |
| **Implications**Extension of potential application to broader contexts (e.g., predictive values, future directions, ramifications, clinical prognosis, professional and/or civic responsibilities). | Clearly identifies and explains substantive potential applications of the results and their broader impacts. | Adequately identifies and explains substantive potential applications of the results and their broader impacts. | Unclear or limited explanation of substantive potential applications of the results and their broader impacts. | Inappropriate or missing explanation of substantive potential applications of the results and their broader impacts. |
| **Limitations** Acknowledgement of and/or reflection on limitations in interpretation and implication that stem from underlying assumptions, data analysis procedures, methods used, and/or characteristics of the data itself (e.g., sample size, skewed, obvious bias). | Accurate and thorough articulation of deficiencies with the underlying data, analyses or conclusions. | Mostly accurate and/or mostly thorough articulation of deficiencies with the underlying data, analyses or conclusions. | Somewhat inaccurate and/or limited articulation of deficiencies with the underlying data, analyses or conclusions. | Inaccurate or missing articulation of deficiencies with the underlying data, analyses or conclusions. |
| **Overall Communication**Following a logical sequence and presenting an explicit chain of reasoning. Use of disciplinary terminology as appropriate. | Consistently clear and logical presentation throughout, using appropriate academic language. | Mostly clear and logical presentation; generally uses appropriate academic language. | Somewhat unclear or illogical presentation; may fail to use appropriate academic language.  | Unclear or illogical presentation; fails to use appropriate academic language.  |

*Not all prompts below apply to every discipline. These prompts are intended to assist faculty to develop/ fine-tune their assignment - they are not all-inclusive.*

**Problem Formulation**

*Translation of the disciplinary/real-world problem into a QR context (e.g., writing a hypothesis, a math model, quantitative instrumentation). Use and interpretation of quantitative data/information to identify or formulate a problem.*

* Does the prompt define for students what the problem is or should students define their own problem?
* How does the assignment ask students to identify their own and others’ assumptions? What different categories of assumptions are students asked to consider (e.g. empirical, value, normative)? How does the prompt engage students in examining the assumptions relevant to the context?
* What information are students given about the context in which they are working?

**Representation/Visualization**

*Depiction of quantitative information such as visual (e.g., figures, charts, tables, equations) and non-visual (e.g., ADA accessibility).*

* What guidance does the prompt offer in terms of the purposes for presenting quantitative information visually?
* What guidance does the prompt offer in terms of the criteria for selecting an appropriate depiction of that information? What guidance does the prompt offer in terms of how to display or present the quantitative information within the final product?

**Quantitative Analysis**

*Selection of analytical methods (e.g., data analysis, solution technique). Use of the selected analytical method.*

* What guidance does the prompt offer in terms of the kinds of calculations/analyses students should perform?
* What guidance does the prompt offer in terms of presenting those calculations/analyses (e.g. how much of their work they should show, the units involved)?

**Interpretation**

*Description of the meaning of the results in the context of the original problem formulation.*

* What guidance does the prompt offer in terms of how students should interpret/explain quantitative information?
* What does the prompt ask students to do with the quantitative information (e.g. should they apply it to answer policy questions)?

**Implications**

*Extension of potential application to broader contexts (e.g., predictive values, future directions, ramifications, clinical prognosis, professional and/or civic responsibilities).*

* What guidance does the prompt offer for extending applications to broader contexts?

**Limitations**

*Acknowledgement of limitations in interpretation and implication that stem from underlying assumptions, data analysis procedures, methods used, and/or characteristics of the data itself (e.g., sample size, skewed, obvious bias).*

* How does the prompt engage students in establishing or questioning the limits of the quantitative evidence?
* What criteria for evaluating reasonableness exist in the situation of the problem? How explicitly are those criteria described (i.e., are they implied by the situation or explicitly described)?

**Overall Communication**

*Follows a logical sequence and presents an explicit chain of reasoning.*

*Uses disciplinary terminology as appropriate.*

* How does the prompt provide guidance for overall clarity and organization? How does the prompt encourage the use of appropriate vocabulary and norms of mathematical/statistical arguments?

**Assignment Essentials**

Students complete assignments to:

* practice applying skills, content, and concepts learned, demonstrate their achievement, and
* to be assessed and receive feedback on the achievement of assignment, course, and program learning outcomes.

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| * How will my assignment prompt students to show what content they have learned and/or demonstrate their skills?
* Does the array of assignments in this class address students with varied learning preferences multiple means of demonstrating knowledge and skill acquisition?
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| Students need *clear and transparent expectations* and instructions documented *in writing*:* Assignment instructions should clearly identify tasks, provide the required format elements, and describe the final product.
* Assignment descriptions should help students clearly understand the main purpose.
* Assignment descriptions should also demonstrate the connections to how their work meets learning outcomes, builds on their knowledge and skills for future assignments, relates to graduation, and has professional relevance.
* A grading rubric that expresses expectations and aligns with the outcomes will assist students as they complete the assignment.
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| * How will assignment instructions clarify what tasks to do, how they are connected, how to get started, and how to complete the tasks?
* How will you know if students met the assignment expectations; how will students be assessed?
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*Chunk and scaffold assignments:* Students perform better on assignments when instructors break them into manageable chunks. Presenting students with smaller assignments that build into a larger one creates the opportunity for early feedback and improvement.

 Example of smaller assignments that build toward a research essay that meets expectations:

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| Course timing | Week 6 | Week 8 | Week 10 | Week 12 | Week 14 |
| Developmental Assignment Due | Thesis statement | Annotated Bibliography | Outline | Essay Draft | Final essay  |

Reflection Aids Retention: Students’ learning improves and sticks when they *reflect* on their process and their completed assignment:

* Ask students to report what they learned from the assignment or what they would do differently in a future assignment.
* Student reflection on assignment process and performance may also help you shape the next version of the assignment.