

Quantitative Reasoning, Critical Thinking, Information Literacy Integrated Rubric Guide

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Faculty who have worked with these rubrics at CSUMB have developed this guide to help you apply the rubric. Although there are often multiple descriptors within any level for a criterion, we suggest that you choose the level based on the balance of evidence rather than grading “down” for weak performance on any of the particular descriptors. To quote from materials developed by Stanford University for scoring teaching samples, “The description requires professional judgment to apply to the evidence; it is not in the form of an item whose presence or absence is readily apparent to noneducators, and perhaps even to nonspecialists.”

The structure of this document follows a consistent pattern. 1) Each criterion is discussed in terms of its big ideas and the progression of those ideas across the levels in fairly broad terms. 2) For each criterion, there is a description of what distinguishes a level 3 (proficient) performance from a level 2 (developing) performance. *(The structure that follows is based on a document created for the Performance Assessment of California Teachers [PACT].)*

Issue/Problem (CT)

1) Big ideas and their progression

Definition of issue--Writers both respond to and create an urgency for the response in writing. They do so by defining a problem or situation and highlighting what is *at issue* about that situation. In the physical sciences, issues are widely agreed upon, and the definition of the issue may be abbreviated or elliptical. In the humanities and social sciences, a great deal of rhetorical work may go into establishing that some situation is problematic and requires resolution. In applied physical scientific research, considerable rhetorical work similar to that required in social sciences may be needed. Across the rubric, this idea progresses from a vague or general definition of the issue to a precise, narrowly bounded definition.

In addition to creating urgency, writers need to address important ambiguities in the knowledge base/literature; this serves to both explore multiple perspectives, and create shared understanding with their audience.

Key Terms--In defining an issue, writers must often negotiate varied definitions of the terms used to describe the issue. Often, the terms have various meanings (for instance in popular versus academic contexts or among disciplinary contexts or even within a single discipline). Across the rubric the definition of terms varies both in terms of the number of ambiguous terms clarified and the quality of that clarification.

Background information--In order for readers to understand both the situation that is problematic and what is problematic about that situation, writers must provide some background information. In physical sciences, often very little background information is needed; whereas in disciplines in the applied sciences and humanities, often a great deal of background information is needed to ensure clear communication of the issue. The levels vary in terms of this idea by the sufficiency of

the information provided in order for readers to have a full and rich understanding of the issue addressed.

2) Level differences

At level 2, A paper can score a 2 on this criterion by framing the issue too broadly or by addressing too many different possible focuses. Or a paper may score a 2 because the author may not define the issue and associated terms clearly for the reader or explain the background enough for the reader. A level 2 paper may simply expect the reader to fill in a lot of information regarding the issue, leaving the reader confused as to the problem or issue being presented.

At level 3, the narrow and focused definition of the issue makes a paper a 3 on this criterion. Terms such as *complexity* or *difficulty* need to be unpacked both in terms of their meaning and the criteria used to determine them in order for a paper to score as proficient in light of this criterion.

Supporting Materials (IL)

1) Big ideas and their progression

Variety of information sources--Different contexts call for different kinds of information sources--primary, personal, journalistic, academic. Depending on the discipline and task, the quantity and range of information sources selected may matter for the quality of the support writers marshal. Some disciplines and tasks require writers to use a variety of sources; others call for solely academic or primary sources. Across the rubric, this element progresses from too few sources to be convincing to appropriately various sources.

Criteria for source selection--In order to ensure a deep engagement with the issue they address, writers select the sources they use carefully, considering such issues as topic, discipline, authorship, currency, audience, point of view. Some areas additionally require engagement with certain foundational sources. More experienced writers consider a greater number of these concerns in selecting their sources. This element may be difficult to assess unless a reference list (works cited, bibliography) is present.

2) Level differences

This criterion is concerned with both quantity and quality of sources, and recognizes that the expectations for these will vary by discipline and assignment. For this reason, much of the determination of what is “appropriate” is based on the scorer’s understanding of the assignment and what the student is trying to accomplish with each source. Because of this, a scorer would not be able to accurately evaluate the supporting materials of a paper based on a decontextualized bibliography. Even within a single assignment, the same type of source would be appropriate support for some purposes but not others. For example, the website of a nonprofit organization may **not** be an appropriate source of statistics on domestic violence, but it could be appropriately cited as a source of data on how many people are reached by this nonprofit’s outreach efforts.

The difference between level 2 and level 3 is mostly a matter of degree, with level 3 having a greater proportion of sources considered appropriate with regard to authority, relevance, and currency. The number of sources may be insufficient to support the writer's quantitative goals at a level 2, while the number will usually be sufficient at level 3.

At Level 2: Multiple sources are used, but the quantity of sources may not allow the student to fully back-up their claims, offer multiple perspectives, or is otherwise insufficient to meet the goals of the assignment. Some of the sources have appropriate authority, currency, and relevance, and others do not.

At Level 3: In order to score a 3 on this criterion, it must be clear that the student has considered the authority of the sources, in addition to currency and relevance. The sources are of a quantity and quality that are, for the most part, appropriate to the discipline and the assignment, though the scorer sees some room for improvement. For example, for a research assignment requiring primarily scholarly sources, some information may be drawn from sources that are credible but not entirely appropriate (e.g. an irrelevant discipline, a trade journal, Smithsonian magazine, etc.). Overall, the sources have a positive impact on establishing the credibility of the student's data.

Methodology

Explicitly describes assumptions, theory, or bias associated with creation, development, or analysis of quantitative forms and applications and provides compelling rationale for why each assumption is appropriate. Evaluates the creation, development, or analysis of quantitative forms and applications based on the limitations of the assumptions.

1) Big ideas and their progression

Describes assumptions, theory, bias--The various perspectives engaged by writers, both their own and others', are based on assumptions about knowledge and the world--whether they are disciplinary or experience based. Depending on the task, writers acknowledge those assumptions in various ways--by identifying limitations in analysis of information, by setting sources with contrasting perspectives into conversation, by explicitly marking those assumptions. Writers at the beginning stages of development are more likely to recognize those assumptions in others' writing than in their own. Writers performing at the more experienced levels of the rubric demonstrate attention to the context, their own assumptions, and those of others. In addition, in Quantitative Reasoning the use quantitative forms and applications requires an additional evaluation of the assumptions or theory used to generate the quantitative forms, evaluate quantitative information, or make predictions/generalizations. For example, a constructed model based on data to evaluate the relationship between two variables requires explicit understanding of the assumptions used to construct the model and use the model for the basis of judgements (see Evaluation).

Explanation and Evaluation of generation of quantitative information-- In applicable assumptions, theory, or biases associated with data generation (creation) must be clearly identified and described. Methods used to summarize data, analyze data, display data, or synthesize information, meta-analysis, etc. the choice of method relies on the assumptions, theory, and/or potential bias associated with the quantitative information or application. In some fields of work there may be no need for creation, development, or analysis of quantitative information explicitly by the writer,

instead the writer relies on other sources for the generation of quantitative information. Regardless, the writer must evaluate the methodology of the other sources.

2) Level differences

The nuances of assumptions, theory, or bias associated with the creation, development or analysis of quantitative information can be difficult to describe and evaluate in situations where they are not explicitly states by other sources or well understood by the writer. As such, the distinction in proficiency is associated with recognizing the full scope of their own or others methodology and describing and evaluating the assumptions, theory, or bias associated with the methodology.

At Level 2: The writer describes most of the assumptions, theory, or biases, but may miss or misinterpret some of them either because they are not explicitly stated within another source or the writer does not understand the assumptions associated with their own methodology. In some cases, the writer may identify assumptions that are not appropriate to the situation A common example in statistics is indicating that a “small” sample of 200 is not large enough to represent a population of 100,000, ignoring the fact that if the sample is representative of the population and analysis of the sample has appropriate evaluation of the certainty of the inferences made with the sample, then 200 is a perfectly reasonable sample size.

At Level 3, the writer describes all necessary assumptions, theories, or biases associated with their own or others’ creation, development or analysis of quantitative information. This will include both explicit assumptions, such as data collection methods, model assumptions, assumptions associated with extrapolation or generalization, but also implicit assumptions, especially in the work of others. In addition, the writer demonstrate a knowledge of understanding the necessity of the described assumptions through the provision of a correct rationale for the described assumptions.

It should be noted that it may not be possible to assess whether the writer appropriately described and evaluated the implicit assumptions of others so it must be determined prior to assessment if this should be considered in the assessment (for example it may not be possible to assess a research paper in this way as there are too many sources that may not be known to the assessor, but it is possible that the assignment was designed to specifically evaluate a known work).

At Level 2, the writer does not describe key assumptions, theory, or biases associated with their own or others’ methodologies or includes assumptions that are not correct. The rationale associated with each assumption is either not provided or not correct, thereby demonstrating that the writer does not fully comprehend the methodology used.

Calculation

1) Big ideas and their progression

Accuracy of calculation--Calculations may be inclusive within other categories (such as calculating percentages to create a pie chart or transposition of musical key or meter within the Representation category), but can still be evaluated exclusively. In addition, Calculation is probably the most likely component of QR to not be present across the curriculum, at least not at a complex level.

Calculation may be as simple as mathematical operations (addition, subtraction), or as complex as integration or differential equations or statistical modeling. Calculation at each level of complexity requires both the ability to perform quantitative procedures and the selection of the most appropriate quantitative procedure. Elegance is evidence of advanced Calculation, as many problems can be solved through brute force procedures, but recognition of an elegant method to calculate a solution demonstrates advanced conceptual understanding of a quantitative procedure (e.g. calculation of an integral using a known property of the integral instead of using rote procedural methods).

Comprehensiveness-- Calculations must be comprehensive as to sufficiently solve the problem and/or provide the appropriate result. The Issue/Problem and chosen Methodology will dictate what is sufficiently comprehensive as a Calculation

Showing of work--In part, showing of work is about presenting all steps of a calculation so that they are easily identifiable and interpretable by the viewer. Elegance, or clarity of calculations, is that the flow of the calculations are logical, easy to comprehend and reproducible. Showing of work may be the quality of Calculation that is most likely to not appear embedded within assignments across the curriculum, but may be provided as a supplement (e.g., reproducible research). Showing of work may include "hand" calculations or computer based work/code.

2) Level differences

The distinction between proficient and not proficient in Calculation is found in three qualities of Calculation:

1. Comprehensiveness - developing work is not fully comprehensive
2. Correctness - developing work is not fully correct
3. Showing of Work - when provision is appropriate, steps are missing

At Level 3, students provide comprehensive and correct work (minor errors may exist but do not detract from the purpose of the work) as is appropriate for the issue/problem and methodology.

At Level 2, students may have comprehensive but partially incorrect calculations to the point it affects their results significantly or their calculations may be correct, but either not comprehensive or unnecessary/extraneous given the issue/problem and/or methodology.

Visual Representation

1) Big ideas and their progression

Accuracy of representation-- Representation is reflective of the quantitative information presented, not misleading, or created to skew perception. The representation must correctly represent the data, but it may not be possible to fully evaluate the correctness of the representation unless full access to the original data or quantitative information is provided.

Completeness-- Representation includes all relevant information. All labels, identifications, legends, etc. are provided and the visualization is reasonably interpretable separate from any written or oral

communication about the visualization. This is not meant to be a nuanced criteria and it should be easily observable from the representation based on the type of representation and context.

Appropriateness-- Representation serves the purpose of the work and is the best suited visualization of the information based on context and audience. Large amounts of information or data may be available to a student, but the student must select the appropriate data in the appropriate form as well as the appropriate quantitative portrayal to best represent the relevant data (graphics, numeric summaries, tables, transpositions, scaled drawings).

2) Level differences

At level 3, proficiency requires that the visual representation meets all three criteria: appropriate, accurate, and complete. A visualization must serve the purpose of the work and should not be extraneous. It is possible that it might not be possible to evaluate accuracy as a whole, in which case the visualization should meet the minimum requirement of being not misleading or created to skew perception. In addition, appropriateness is context specific and may vary depending of discipline or purpose of work, as there may be more than one reasonable method for representation of the quantitative information. If missing details associated with completion are minor and do not detract from the understanding of the visualization then a student may still be considered proficient if their visualization meets the other two criteria.

At level 2, partial consideration of one or more of the criteria indicates that a student is still developing in this category. Either missing details associated with completeness detract from the understanding of the visualization or there are minor inaccuracies associated with the data/information or might slightly mislead or skew information. It is possible that the visualization is correct and accurate, but is not completely appropriate given the context or purpose of work associated with the issue/problem. As such, the evaluation of the completeness and accuracy criteria is more straightforward, but the appropriateness is a judgement based on the context, purpose of work, or even the discipline.

Interpretation

1) Big ideas and their progression

Accuracy of identification--A student who demonstrates the ability to interpret in QR will be able to correctly identify a quantitative form, key information contained within the quantitative form, and identify possible missing information or information not directly represented in the quantitative form when appropriate. The student will be able to generalize the information, describe what information is provided, what *general* conclusions may be drawn from the information provided in the context of the problem.

Precision of Description-- A precise description includes explicit description of units associated with quantitative information and the context to which the quantitative information applies.

2) Level differences

At level 3, within student work, there might be numerous interpretations included in the construction of an argument or purpose of work. Therefore, to be proficient all interpretations must be accurate and precise in description. If among the numerous interpretations there is one or two minor issues with the descriptions, a student may still be judged proficient if almost all of the interpretations meet the proficiency definition.

At level 2, lack of context and units within many of the interpretations or missing information in some interpretation indicates a developing level of interpretation whereas at proficiency there would be consistent interpretation which includes both accuracy of interpretation and precision of description.

Evaluation

1) Big ideas and their progression

Incisiveness of judgment--The ability to make meaningful and insightful decisions based on and supported by the quantitative information or form presented or created. Conclusions made are specific and informed and may appropriately extrapolate beyond the information provided if supported by evidence or common knowledge. The limitation of the analysis/methodology are recognized and incorporated in the conclusions of the evaluation.

Qualification of conclusions-- The generalizability of quantitative information is often overlooked. Information interpreted may be accurate and descriptive, but when used to make a judgement or conclusion is overly generalized or misapplied. Therefore, qualifying the certainty of conclusions as well as being comprehensive in the evaluation of quantitative information is vital to quantitative reasoning.

2) Level differences

At level 3, the distinguishing factor between developing and proficient in Evaluation is the level of qualification of conclusions based on quantitative information. For example, the results of a drug study might show that it reduces anxiety in patients. A proficient evaluation would indicate the proportion of reduction in anxiety, whether the reduction of anxiety was to manageable levels, and if there were any limitations on the generalizability of the results. The careful qualification of a conclusion sets it apart as proficient in evaluation. Certainty may be qualified or quantified using statistical methods or, when appropriate or necessary, using ad hoc qualification based on the Methodology.

At level 2, while plausible conclusions may be provided based on the quantitative information, it may be vague or not comprehensive. For example, if the only statement is that the results of a drug study shows that it reduces anxiety in patients. That is a plausible evaluation of quantitative information but not comprehensive and with no qualification of certainty. Even if comprehensive and competent judgements are provided, exceeding the level of vague and simply plausible conclusions, if there is not qualification of certainty then the student is still developing in evaluation.

Coherence/Purpose

1) Big ideas and their progression

Organization--Once writers have developed a set of quantitative applications, they must structure those judgments and conclusions in ways that suits the genre and purpose of their task.

Synthesis--Developing new knowledge based on quantitative information requires that analysts identify patterns of agreement, disagreement, and nuance among the conclusions from their applications. Across the rubric, this idea progresses from little or no synthesis to synthesis that fully realizes the writer's apparent purpose.

Transitions--Skillful use of transitions helps readers follow logical nuances in a writer's prose, building not only connection from one point to the next but also an overall sense of coherence in the work. A focus on transitions includes not only the conventional "transitional words and phrases" but other strategies for coherence such as repetition, reference, and parallelism. The skill with which writers lead their readers through their reasoning distinguishes the levels in this element of the criterion. Use of and explanation of the ways the quantitative evidence is used to either support or refute a claim or position. In addition, explanation of how and why the quantitative evidence is presented or explained for the purpose of the work.

2) Level differences

At level 3, the distinction in proficiency from developing in Coherence/Purpose is synthesis. A proficient student in coherence would synthesize the evaluation of quantitative information to form a clear and effective argument aligned with the Issue/Problem while also considering Methodology in the possible limitations and bias that might inform the synthesis.

At level 2, it is not uncommon to see a litany of interpretations and evaluations of quantitative information with no synthesis of the information to support a purpose of work or argument. While the provided interpretations and evaluations may be relevant to the purpose of the work, without synthesis, the true purpose of the work is not realized and is therefore not proficient.

Reasonableness

1) Big ideas and their progression

Identification-- In contrast to other aspects of QR, in which the student may be involved in the creation, application, or inferences based on a quantitative form, assessment of reasonableness may be exhibited in situations where a student evaluates another person's solution or inference based on quantitative information. The ability to assess reasonableness is especially important for students to be able to siphon through quantitative information thrown at them from the media, government or academia to assess the reasonableness. The student must identify if a result or inference is sensible given context, certainty in inference, methodology that led to the inference, and general knowledge. In many cases, it might be implicit that the student identified an inference as

reasonable given their treatment of the inference within evaluation and coherence and explicit in identification of a solution/inference as not sensible.

The hope is the student will have already evaluated the sensibility of their own work prior to communication of results. If there is evidence that the student did not evaluate the sensibility of their own results, then that is evidence the student is still at the beginner stage of developing Reasonableness. It might be useful for some assignments to evaluate reasonable in each situation (own work and others' work) as two separate categories.

Justification-- Identification is the first step to developing in reasonableness, but it is not until a student is able to also justify that identification that they are proficient. Justifications may include the context of the inference, certainty in inference, methodology that led to the inference, and general knowledge.

Limitations--If student is able to identify the exact source of error in an inference or solution and/or re-qualify the inference so that it is now sensible when the original inference was not sensible, that is evidence that the student can explain the limitations of the inference that were originally not understood within the original inference (whether it was their own inference or others' inference).

2) Level differences

At level 3, the student can both correctly identify and justify whether an inference is not sensible explicitly, but may implicitly demonstrate correct identification/justification as sensible through their treatment of the inference/solution within the evaluation and coherence/purpose. Justification must be explicit in both cases as it would be a part of the evaluation process generally.

At level 2, the student is able to simply identify the sensible or not sensible solution or inference, but cannot or does not justify that assessment.

Academic Integrity (IL)

1) Big ideas and their progression

Distinctions in levels for this criterion relate to the degree of consistency with which the student does each of the following:

Attributes information to sources--While disciplines vary in the conventions they use to do so, all academic disciplines in the U.S. call upon students to distinguish between their own ideas and the ideas of others and to enable readers to trace information to its source.

Appropriately chooses to paraphrase, summarize, or quote--This element varies significantly across contexts. In some disciplines--such as the social sciences and physical sciences--quoting from sources is unusual, in humanistic disciplines quotations are central to the academic endeavor.

Uses information in ways that are true to original context--Students include information/data and state positions for a variety of purposes, not always because they represent the perspective of the source's author. This element refers to the student's selection of information or data from sources and their ability to distinguish the purpose for which that information was used in its original context.

Distinguishes between common knowledge and ideas requiring attribution--While sources can be found for almost any information, some knowledge is so widespread as to require no attribution. This element refers to the student's ability to distinguish that information from information that is specific to particular sources.

Acquires information ethically and legally--This element is difficult to assess in finished products, as it relates to the *process* of knowledge collection, but in instances in which that process is evident in the student artifact, standards of conduct regarding research--both primary and secondary--should be applied.

2) Level differences

At level 2, students may show an over-reliance on direct quotation and/or inconsistency in attribution and citation. Additionally, students may use information in ways that misrepresent the original context. They may provide citations for ideas that are common knowledge or fail to cite ideas requiring attribution. The reader may have occasional difficulty distinguishing between the student's own ideas and the ideas of others.

At level 3, sources are consistently cited and there is a greater balance (appropriate to the discipline) between direct quotation and paraphrase or summary. Student attributes information to sources appropriately, and chooses to paraphrase, summarize, or quote in ways that are true to the original context. Student distinguishes between common knowledge and ideas requiring attribution.