UofL **Cardinal Core Curriculum Committee** **MITC 161**
**Cardinal Core Office** **(502) 852-8113**

# Cardinal Core Assessment of Quantitative Reasoning (Spring 2019 Sample)

## Cardinal Core Program (Effective Summer 2018)

The Cardinal Core program at the University of Louisville prepares students to do the advanced work needed for their baccalaureate degrees and prepares them to contribute to society throughout their lives through their professional work and civic engagement. The program emphasizes the development of key intellectual skills relevant to any career path: critical thinking, quantitative reasoning, effective communication, and the understanding of historical, social, and cultural diversity. Students will develop these intellectual skills in the following content areas of Arts and Humanities, Historical Perspectives, Oral Communication, Quantitative Reasoning, Social and Behavioral Sciences, Natural Sciences, Written Communication, and the competency area of Diversity in the United States and Globally. Upon completion of the program, students will be prepared to analyze complex problems and evaluate possible courses of action in an environment characterized by diversity and the need for sustainable solutions.

## Assessment Administration

The assessment of student learning outcomes is a national expectation in higher education. Section 8.2.b of the Southern Association of Colleges and Schools' (SACS) accreditation standards requires that the institution identify student learning outcomes for collegiate-level general education competencies in its undergraduate degree programs, assess the extent to which it achieves these outcomes, and provide evidence of seeking improvement based on analysis of the results. Further, the Kentucky Council on Postsecondary Education (CPE) states that "All Kentucky public universities and KCTCS colleges are expected to assess, in accordance with SACS-COC Principles of Accreditation and based upon nationally accepted standards, the student learning outcomes associated with their general education programs, indicate a relationship to the faculty-generated Statewide General Education Student Learning Outcomes, and provide evidence of ongoing assessment that ensures comparability for transfer purposes on a three-year cycle."

The Cardinal Core Curriculum Committee (CCCC) is charged with continued oversight of the assessment of student learning outcomes across the Cardinal Core curriculum to support the continuous improvement of the Cardinal Core program in alignment with SACS and CPE requirements. The assessment operates on a three-year cycle, in which samples of student work are collected from one content area each semester and assessed by a panel of trained faculty. The CCCC began a pilot of the Association of American Colleges and Universities (AAC&U) VALUE (Valid Assessment of Learning in Undergraduate Education) Rubrics in the first cycle of the Cardinal Core Assessment. Specifically, the Critical Thinking, Intercultural Knowledge and Competence, Oral Communication, Quantitative Literacy, and Written Communication VALUE Rubrics will be used to measure the Cardinal Core program's overarching intellectual skills of critical thinking, effective communication, quantitative reasoning, and social, historical, and cultural diversity.

The Spring 2019 assessment was focused on courses in the Quantitative Reasoning content area. Student work samples from Quantitative Reasoning courses were assessed with the AAC&U Quantitative Literacy VALUE Rubric. The University of Louisville Student Learning Outcomes and the AAC&U VALUE Rubric Measures used to assess student work in the Quantitative Reasoning content area are provided below. The University of Louisville Quantitative Reasoning Outcomes were adopted from the Kentucky Statewide General Education Student Learning Outcomes.

**University of Louisville Quantitative Reasoning Learning Outcomes/Kentucky Statewide General Education Student Learning Outcomes**

Quantitative Reasoning is concerned with solving real-world problems through mathematical methods. Students who satisfy this requirement will demonstrate that they are able to do all of the following:

1. Interpret information presented in mathematical and/or statistical forms.
2. Illustrate and communicate mathematical and/or statistical information symbolically, visually, and/or numerically.
3. Determine when computations are needed and execute the appropriate computations.
4. Apply an appropriate model to the problem to be solved.
5. Make inferences, evaluation assumptions, and assess limitations in estimation, modeling, and/or statistical analyses.

**AAC&U VALUE Rubric Measures**

*Quantitative Literacy VALUE Rubric*

(QL1) Interpretation: Ability to explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words)
(QL2) Representation: Ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words)
(QL3) Calculation
(QL4) Application/Analysis: Ability to make judgements and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis
(QL5) Assumptions: Ability to make and evaluate important assumptions in estimation, modeling, and data analysis
(QL6) Communication: 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)

The AAC&U VALUE Rubrics use a four-point scale, with Capstone Level 4 indicating the highest level of performance, followed by Milestone Level 3, Milestone Level 2, and Benchmark Level 1. In addition, a score of zero can be assigned to any work that does not meet the

benchmark level performance and "not requested" could be assigned for assignments that did not provide an opportunity for the student to demonstrate the criterion within the rubric measure.

**Assessment Process**

For the Spring 2019 assessment of student work from the Quantitative Reasoning (QR) content area, the Cardinal Core Office collaborated with department chairs regarding the details of the upcoming assessment to ensure faculty participation and appropriate sampling. A formal memo outlining the project and process was also provided to each of the department chairs and to all faculty teaching Cardinal Core courses within the Quantitative Reasoning content area prior to the start of the semester to ensure a mutual understanding of project expectations. The initial communication provided a timeline for collection of assignment prompts, answer keys, and student work.

After the semester withdrawal deadline passed, the Cardinal Core Office retrieved the class rosters for all QR Cardinal Core courses from the Office of the Registrar and selected a stratified random sampling, to ensure that the sample included students from all courses. Instructors of all QR courses were sent a list of students selected for the assessment along with detailed instructions requesting that instructors provide a copy of one assignment with answer key, along with the ungraded responses for the selected students to be sent via email to the Cardinal Core Office service account.

Student artifacts were collected and stored in an electronic repository and uploaded into the LiveText© assessment management system. A panel of faculty (tenured and tenure-track faculty, term faculty, and adjunct faculty), graduate teaching assistants, and REACH (Resources for Academic Achievement) Mathematics staff assessed student artifacts. The AAC&U Quantitative Literacy VALUE Rubric was applied to all student artifacts.

Prior to the assessment reading, assessors were brought together for a four-hour training session coordinated by the Cardinal Core Office. In the training session, the assessment process and context for Cardinal Core Assessment at the University of Louisville were presented. Faculty engaged in dissection and discussion of rubric criteria, and faculty assessors individually reviewed and scored benchmark sample assignments. Benchmarks were assignments selected to represent a wide range of content and skill development in order to give the assessors a baseline for measuring expectations of learning and evaluating student performance (Herman, Osmundson, & Dietel, 2010). Assessors then engaged in discussion about the benchmark assessment scores to share their rationales for why particular scores were selected. To highlight the reliability of the training scoring, the results from scoring benchmark samples for the Quantitative Literacy VALUE Rubric are provided in Appendix A.

At the start of the assessment reading day, each faculty assessor was assigned a username and password for one of three LiveText© accounts and a list of courses and sections to assess. Three readers assessed each artifact so that scores could be compared across assessors for reliability purposes.

**Data Collection Overview**

The enrollment for Quantitative Reasoning Cardinal Core courses in Spring 2019 was approximately 1488 students after the withdraw deadline. The Cardinal Core Office requested a sample of 501 from courses in the College of Arts and Sciences (Criminal Justice Department, Mathematics Department, and Psychology Department) and the J.B. Speed School of Engineering. The final sample received (students who completed the selected assignment) and determined eligible (legibility, grading removed, etc.) for assessment was 274 student work samples.

**Summary of Assessment Data**

For the assessment of Quantitative Reasoning outcomes, 274 student artifacts were assessed by faculty and graduate teaching assistants from the College of Arts & Sciences and the J.B. Speed School of Engineering, as well as REACH (Resources for Academic Achievement) Mathematics staff using the AAC&U Quantitative Literacy VALUE Rubric.

Table 1 provides the percentage of work samples scored at each rubric level for the Quantitative Literacy VALUE Rubric. A calculation of the percentage of students who scored at a *3* or *4* is also provided as a baseline target for future assessments.

Table 1

*Percentage of Artifacts Scored at Each Rubric Level for Quantitative Literacy*

| | **QL1** | **QL2** | **QL3** | **QL4** | **QL5** | **QL6** |
|---|---|---|---|---|---|---|
| Capstone (4) | 16.7% | 10.8% | 16.2% | 7.1% | 3.1% | 11.6% |
| Milestone (3) | 24.8% | 32.0% | 26.2% | 24.1% | 7.7% | 38.3% |
| Milestone (2) | 21.0% | 29.4% | 34.0% | 29.9% | 21.4% | 19.0% |
| Benchmark (1) | 30.0% | 19.9% | 16.4% | 19.2% | 33.8% | 16.1% |
| (0) | 7.6% | 8.0% | 7.2% | 19.7% | 34.0% | 14.9% |
| **% Scored at 4 & 3** | **41.4%** | **42.8%** | **42.3%** | **31.2%** | **10.8%** | **49.9%** |

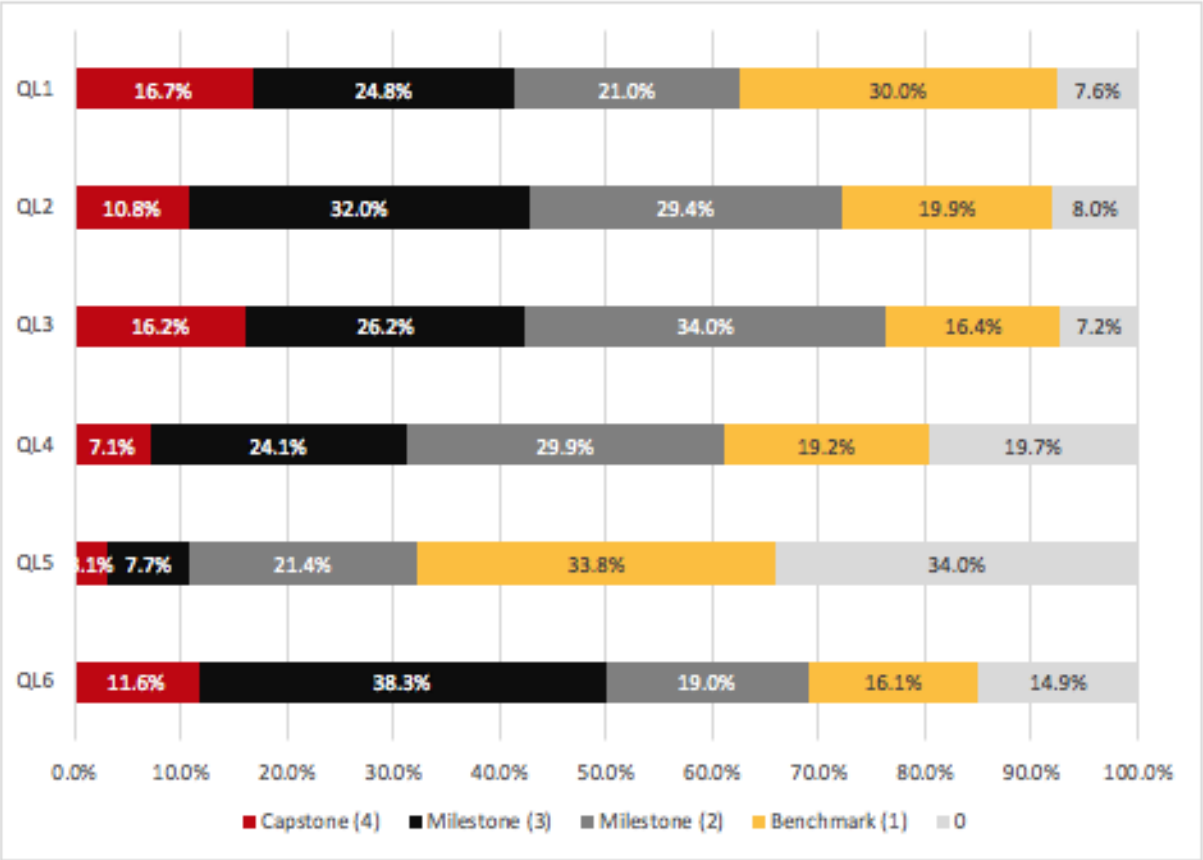


*Figure 1. Percentage of Artifacts Scored at Each Rubric Level for Quantitative Literacy*

The mean and mode for each Quantitative Literacy VALUE Rubric measure is provided in Table 2. The mode was at *"Milestone (3)"* for QL2 (Representation) and QL 6 (Communication), was at *"Milestone (2)"* for QL3 (Calculation) and QL4 (Application/Analysis), while QL1 (Interpretation) was at *"Benchmark (1)"* and QL5 (Assumptions) was at *"0"*.

Table 2

*Mean and Mode for Quantitative Literacy VALUE Rubric*

| | QL1 | QL2 | QL3 | QL4 | QL5 | QL6 |
|---|---|---|---|---|---|---|
| Mean | 2.1 | 2.2 | 2.3 | 1.8 | 1.1 | 2.2 |
| Mode | 1 | 3 | 2 | 2 | 0 | 3 |

**Inter-rater Reliability**

Three separate readers assessed each student artifact. Table 3 displays the mean score for the three separate readings of all artifacts.

Table 3

*Inter-rater Summary for Quantitative Literacy VALUE Rubric Measures*

| | Assessor 1 | Assessor 2 | Assessor 3 | Standard Deviation |
|---|---|---|---|---|
| QL1 | 2.07 | 2.23 | 2.08 | .09 |
| QL2 | 2.24 | 2.15 | 2.14 | .06 |
| QL3 | 2.24 | 2.34 | 2.25 | .06 |
| QL4 | 1.93 | 1.74 | 1.73 | .11 |
| QL5 | 1.17 | 1.03 | 1.22 | .10 |
| QL6 | 2.00 | 2.25 | 2.21 | .13 |

In addition to the descriptive statistics, Table 4 provides multiple measures of inter-rater reliability. The percentage agreement value was calculated to determine the percentage of artifacts for which all three assessors scored at either the same or within one performance level. Values for *Total Agreement* provided in Table 9 represent the percentage of artifacts for which all three assessors selected the same score (e.g., Assessors 1, 2, and 3 all selected *3*). *Agreement (within 1 level)* represents the percentage of artifacts for which all three assessors scored the artifact at the same performance level or within one level (e.g., Assessor 1 selected a score of *3*, Assessor 2 selected a score of *2*, and Assessor 3 also selected a score of *2*). If the assessor assigned "not requested" for the artifact that was treated as a 0 for the inter-rater reliability analysis since a *0* and "not requested" would both indicate the reviewer did not see the student demonstrate any component of the rubric measure.

In addition to percentage agreement, a one-way, average-measures intra-class correlation coefficient (ICC) was calculated to assess inter-rater reliability. ICC coefficients between .75 and 1.00 are considered excellent, .60 to .74 considered good, .40 to .59 fair, and below .4 is considered poor (Cicchetti, 1994).

Table 4

*Inter-rater Reliability for Quantitative Literacy VALUE Rubric Measures*

| Competency Measure | Total Agreement | Agreement (within 1 level) | ICC | 95% Confidence Interval |
|---|---|---|---|---|
| QL1 | 18.6% | 70.3% | .82 | (.78-.85) |
| QL2 | 26.6% | 81.7% | .87 | (.84-.89) |
| QL3 | 26.0% | 81.1% | .87 | (.85-.90) |
| QL4 | 18.9% | 64.7% | .83 | (.79-.86) |
| QL5 | 39.0% | 71.5% | .74 | (.57-.86) |
| QL6 | 19.5% | 64.4% | .82 | (.79-.86) |

## Syllabus Review

The Provost requests that all faculty load their syllabi to Blackboard© each semester. These syllabi are then available through the university's course catalog system. For the purpose of this review, the Cardinal Core Office collected all Quantitative Reasoning (QR) syllabi that were loaded to Blackboard in Spring 2019.

The review of syllabi sought to answer two questions:

1) Does the syllabus contain the content specific Cardinal Core learning outcomes approved for the course?
2) Are assessment methods stated that support the content-specific Cardinal Core learning outcomes approved for the course?

An evaluation of the congruence between the listed assessment methods with the content specific approved Cardinal Core learning outcomes was not conducted when a reviewer determined that the syllabus does not contain a statement of the approved content specific Cardinal Core learning outcomes.

The syllabus review included syllabi from all 64 Quantitative Reasoning Cardinal Core course sections offered in the spring of 2019 resulting in a 100.0% sample. Appendix Table 1 provides a breakdown of the number of Cardinal Core syllabi available, the number of syllabi with the outcomes stated, and the number of syllabi (from those that included outcomes) that also included the assessment methods.

Table 5

*Quantitative Reasoning (QR) Syllabus Review*

| | **Syllabi Available** | **QR Outcomes Listed in Syllabus** | **Assessment Methods** |
|---|---|---|---|
| **QR Courses** | **64 (100.0%)** | **60 (93.8%)** | **64 (86.5%)** |

The review of 64 Cardinal Core syllabi identified 60 syllabi (93.8%) contained the Quantitative Reasoning (QR) Cardinal Core learning outcomes approved for the course. Further review of the 60 syllabi containing the QR Cardinal Core learning outcomes revealed that 59 syllabi (92.2%) also listed the assessment methods for the Cardinal Core outcomes.

The Cardinal Core Curriculum Committee (CCCC) has continued to emphasize the importance of incorporating the Cardinal Core learning outcomes into course syllabi. Integration of the Cardinal Core outcomes into the syllabus is one indication to the committee that faculty are incorporating the learning outcomes into the course curriculum.

## Summary and Plan for Improvement

The Quantitative Reasoning assessment was the first assessment of the Cardinal Core program and will serve as a baseline for future assessments. While the results indicate lower performance

on the Quantitative Literacy VALUE Rubric than we saw on the Critical Thinking, Written Communication, and Intercultural Knowledge and Competence VALUE Rubrics from the fall 2018 Arts & Humanities assessment, the reason for lower scores may have more to do with the assignments selected for the assessment than actual student performance.

Faculty who participated as assessment scorers recognized early in the assessment training that the AAC&U Quantitative Literacy VALUE Rubric was significantly different from the previous Mathematics rubric used under the old General Education Program. While the Quantitative Literacy VALUE Rubric was shared with faculty in advance of the assessment when requesting an assignment, even those faculty participating as assessment reviewers mentioned that they did not realize that there would be a new rubric and therefore had continued to select assignments that were aligned with the old Mathematics rubric. As a result of this finding, the Cardinal Core Office will work more closely with the departments offering QR courses to ensure that the assignments selected for future assessments more closely align with the expectations of the rubric.

To support familiarity with the Quantitative Literacy VALUE Rubric and other VALUE Rubrics adopted by the university, a group of faculty and assessment staff participated in VALUE Rubric Calibration Training in summer 2019. One faculty member from the Mathematics department successfully completed training on the Quantitative Literacy VALUE Rubric. His experience will help to provide greater clarification of assessment criteria and terminology in the rubric to support internal assessment efforts.

References

Association of American Colleges and Universities. (2009). *Critical Thinking VALUE Rubric.* Retrieved from https://www.aacu.org/value/rubrics/critical-thinking

Association of American Colleges and Universities. (2009). *Intercultural Knowledge and Competence VALUE Rubric.* Retrieved from https://www.aacu.org/value/rubrics/intercultural-knowledge

Association of American Colleges and Universities. (2009). *Written Communication VALUE Rubric.* Retrieved from https://www.aacu.org/value/rubrics/written-communication

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment, 6*(4), 284-290. doi: 10.1037/1040-3590.6.4.284

Fletcher, I., Mazzi, M., & Nuebling, M. (2011). When coders are reliable: The application of three measures to assess inter-rater reliability/agreement with doctor–patient communication data coded with the VR-CoDES. *Patient Education and Counseling*, *82*(3), 341-345. doi:10.1016/j.pec.2011.01.004

Hallgren, K. A. (2012). Computing inter-rater reliability for observational data: An overview and tutorial. *Tutorials in Quantitative Methods for Psychology*, *8*(1), 23-34.

Herman, J. L., Osmundson, E., & Dietel, R. (2010). *Benchmark Assessment for Improved Learning.* (AACC Report). Los Angeles, CA: University of Cali

## Appendix A. Results from Assessment Training for Quantitative Literacy VALUE Rubric

Table 1. Quantitative Literacy VALUE Rubric

*Results of Benchmark Sample 1 – Quantitative Literacy VALUE Rubric*

| Measures | Capstone (4) | Milestone (3) | Milestone (2) | Benchmark (1) | (0) |
|---|---|---|---|---|---|
| **QL1** | *0* | 27.3% | 63.6% | *9.1%* | *0* |
| **QL2** | *0* | 33.3% | 66.7% | *0* | *0* |
| **QL3** | *0* | 6.7% | 93.3% | *0* | *0* |
| **QL4** | *0* | 30.0% | 60.0% | 10.0% | *0* |
| **QL5** | *0* | *0* | 25.0% | 25.0% | 50.0% |
| **QL6** | 9.1% | 36.4% | 27.3% | 18.2% | 9.1% |

*Results of Benchmark Sample 2 – Quantitative Literacy VALUE Rubric*

| Measures | Capstone (4) | Milestone (3) | Milestone (2) | Benchmark (1) | (0) |
|---|---|---|---|---|---|
| **QL1** | 53.3% | 46.7% | *0* | *0* | *0* |
| **QL2** | 33.3% | 66.7% | *0* | *0* | *0* |
| **QL3** | 66.7% | 33.3% | *0* | *0* | *0* |
| **QL4** | 20.0% | 73.3% | 6.7% | *0* | 0 |
| **QL5** | 20.0% | 6.7% | 26.7% | 13.3% | 0 |
| **QL6** | 53.3% | 46.7% | *0* | *0* | *0* |

*Results of Benchmark Sample 3 – Quantitative Literacy VALUE Rubric*

| Measures | Capstone (4) | Milestone (3) | Milestone (2) | Benchmark (1) | (0) |
|---|---|---|---|---|---|
| **QL1** | 21.4% | 78.6% | *0* | *0* | *0* |
| **QL2** | 13.3% | 73.3% | 13.3% | *0* | *0* |
| **QL3** | 13.3% | 86.7% | *0* | *0* | *0* |
| **QL4** | *0* | 66.7% | 33.3% | *0* | *0* |
| **QL5** | *0* | 100.0% | *0* | *0* | *0* |

| | | | | | |
|---|---|---|---|---|---|
| **QL6** | *33.3%* | 66.7% | *0* | *0* | *0* |

*Results of Benchmark Sample 4 – Quantitative Literacy VALUE Rubric*

| **Measures** | **Capstone (4)** | **Milestone (3)** | **Milestone (2)** | **Benchmark (1)** | **(0)** |
|---|---|---|---|---|---|
| **QL1** | *0* | *0* | 14.3% | 28.6% | 57.1% |
| **QL2** | *0* | 6.7% | 20.0% | 26.7% | 46.7% |
| **QL3** | *0* | *0* | 6.7% | 40.0% | 53.3% |
| **QL4** | *0* | *0* | *0* | 6.7% | 93.3% |
| **QL5** | *0* | *0* | *0* | 11.1% | 88.9% |
| **QL6** | *0* | *0* | *0* | *0* | 100.0% |

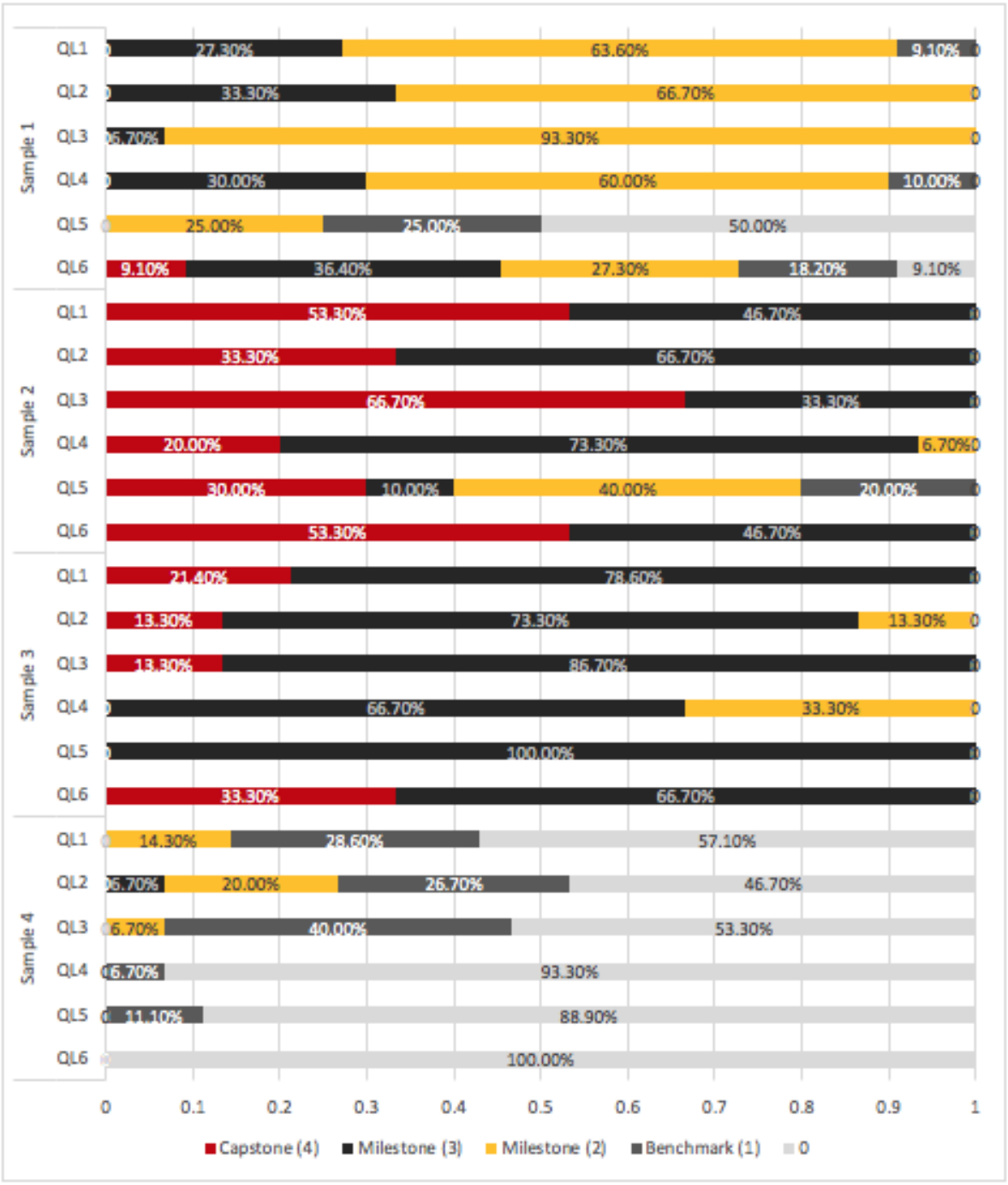


*Figure 1. Quantitative Literacy VALUE Rubric Training Results*