UNIVERSITY OF LOUISVILLE

**Cardinal Core Curriculum Committee**
**Cardinal Core Office**
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# Cardinal Core Assessment of Quantitative Reasoning (Fall 2022 Sample)

## Cardinal Core Program

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 Commission on Colleges' (SACSCOC) 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 SACSCOC 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 SACSCOC 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 Fall 2022 assessment was focused on the program's overarching competency of quantitative reasoning and specifically reviewed student work samples from courses in the Quantitative Reasoning (QR) content area. The CCCC has designated the American Association of Colleges & Universities (AAC&U) Quantitative Literacy VALUE Rubric as the instrument to measure the program's quantitative reasoning competency area.

**University of Louisville Quantitative Reasoning Learning Outcomes/Kentucky Statewide General Education 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, evaluate 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 four scoring categories, with *4* indicating performance of the measure as "capstone" level, *3* indicating performance at "milestone," *2* indicating "milestone," and *1* indicating performance at "benchmark." In addition, a score of zero can be assigned to any work that does not meet the benchmark level performance. The University of Louisville further disaggregates the zero option into a "not applicable" rating that can be selected for assignments that did not provide an opportunity for the student to demonstrate the criterion within the rubric measure, as opposed to the student simply not demonstrating the rubric criteria.

**Assessment Process**

For the Fall 2022 assessment of student work from the Quantitative Reasoning (QR) content area, the Cardinal Core Office collaborated with all departments offering Cardinal Core QR courses. A formal memo outlining the project and process was provided to all faculty teaching Cardinal Core courses within the QR 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 and student work.

Mid-semester, 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 copies of one assignment for the selected students to be sent via email to the Cardinal Core Office service account. To ensure reviewers could also assess student calculations, instructors were asked to provide an answer key for the assignment that they selected for assessment.

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 Achivement) Mathematics staff assessed student artifacts. The AAC&U Critical Quantitative Literacy VALUE Rubrics was applied to all student artifacts.

Prior to the assessment reading, assessors completed mandatory training/rubric norming. Training materials were developed in collaboration with the CCCC Assessment Subcommittee and based upon UofL's long-standing general education assessment training practices, as well as AAC&U VALUE Institute training procedures. All participants were required to complete an asynchronous training module, consisting of an overview of the assessment process and holistic assessment practices, a dissection of the Quantitative Literacy VALUE rubric, and scoring of 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 were given a week to complete the training module in Blackboard and submit their scores for all benchmark samples. The results of the benchmark scoring were compiled, presented, and discussed at an in-person collaborative meeting. Competency areas (rubric rows) with disagreement among reviewers were discussed in the findings shared with reviewers to clarify intended applications of the rubrics. The results from scoring benchmark samples for the Quantitative Literacy VALUE Rubric are provided in Appendix A.

After completion of the assessment training/rubric norming, each 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. Assessors were given a week to complete all assessments.

**Data Collection Overview**

The enrollment for Quantitative Reasoning (QR) Cardinal Core courses in Fall 2022 was approximately 2376 students at the time the sample for the assessment was selected. The Cardinal Core Office waited to identify a sample after the deadline to withdraw from courses passed and received 390 student work samples. Samples were included from the College of Arts & Sciences (Communication, Criminal Justice, Geography and Geosciences, Mathematics, and

Urban and Public Affairs), the College of Education and Human Development (Health & Sport Sciences), the School of Public Health, and the Speed School of Engineering.

**Summary of Assessment Data**

For the assessment of Quantitative Reasoning outcomes, 390 student artifacts were assessed 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. All AAC&U VALUE Rubrics provide an option for a "0" score and for purposes of understanding why a "0" was assigned, the Cardinal Core Assessment provided reviewers with the option of "Not Applicable". The "Not Applicable" indicates an absence of the assessment criteria due to the type of assignment, while a "0" indicates that the student could have demonstrated the criteria and did not.

Table 1

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

| | QR1 | QR2 | QR3 | QR4 | QR5 | QR6 |
|---|---|---|---|---|---|---|
| Capstone (4) | 18.5% | 12.6% | 13.8% | 9.9% | 5.6% | 12.6% |
| Milestone (3) | 28.7% | 31.6% | 33.4% | 27.8% | 8.5% | 39.3% |
| Milestone (2) | 29.5% | 32.4% | 32.4% | 34.4% | 16.4% | 24.7% |
| Benchmark (1) | 20.9% | 15.0% | 15.3% | 21.5% | 12.7% | 15.9% |
| (0) | 2.5% | 3.5% | 3.2% | 4.9% | 5.0% | 4.4% |
| Not Applicable (NA) | 0.0% | 5.0% | 1.8% | 1.5% | 51.7% | 3.2% |

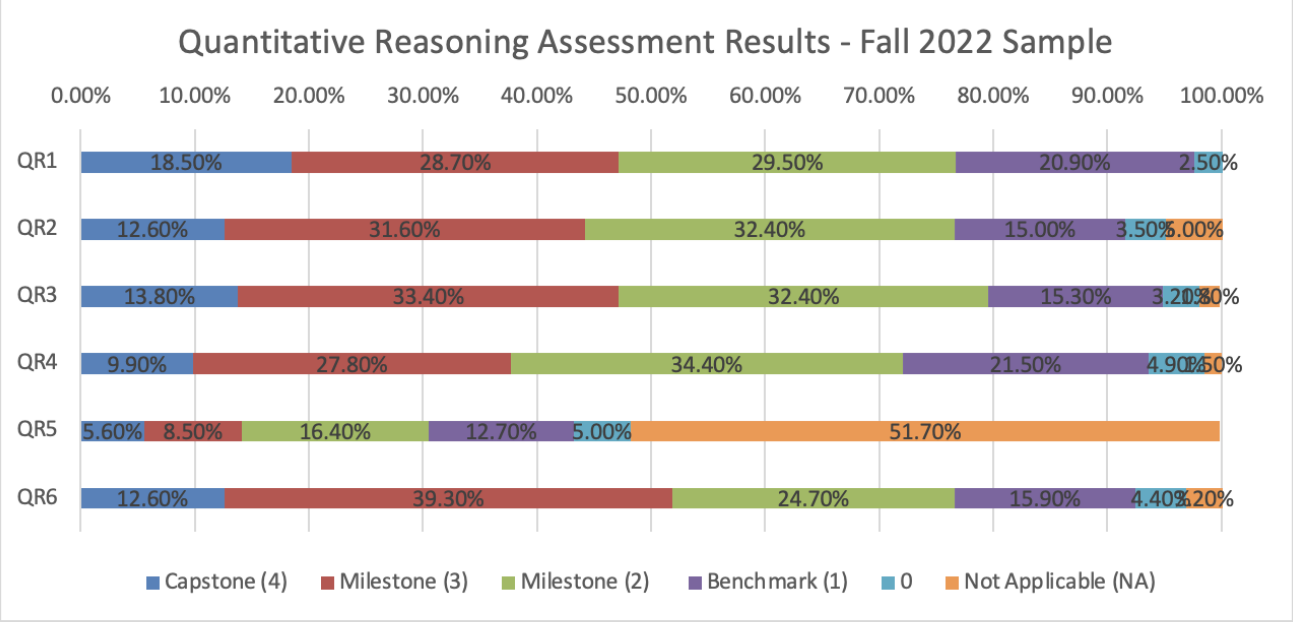


*Figure 1. Percentage of Artifacts Scored at Each Rubric Level for Quantitative Reasoning*

In alignment with AAC&U VALUE Institute practices, scores for each individual work sample were calculated based upon scores assigned by three separate reviewers. The scores from all

three reviewers were averaged and rounded to determine individual work sample scores for each rubric row. The mode for the individual work sample scores is provided in Table 2.

Table 2
*Mode of Individual Work Sample Scores*

| | Mode |
|---|---|
| QR1 – Interpretation | 3 |
| QR2 – Representation | 2 |
| QR3 – Calculation | 2 |
| QR4 – Application/Analysis | 2 |
| QR5 – Assumptions | 1 |
| QR6 – Communication | 3 |

**Comparison to Baseline Quantitative Reasoning Assessment Results (2018)**

This was the second assessment of Quantitative Reasoning under the Cardinal Core program. The results from 2018 were considered baseline results to give faculty an idea of student strengths and weaknesses related to the program's quantitative reasoning competencies. A comparison of results from the Fall 2018 collection of work samples and Fall 2022 work samples is provided in Table 3, the percentage of work samples scored at the highest two levels of performance (4 and 3) are provided for the comparison.

Table 3
*Comparison to Baseline Quantitative Reasoning Assessment Results (2018)*

| | 2018 | 2022 |
|---|---|---|
| QR1 | 41.4% | 47.2% |
| QR2 | 42.8% | 44.2% |
| QR3 | 43.4% | 47.3% |
| QR4 | 31.2% | 37.7% |
| QR5 | 10.8% | 14.1% |
| QR6 | 49.9% | 51.9% |

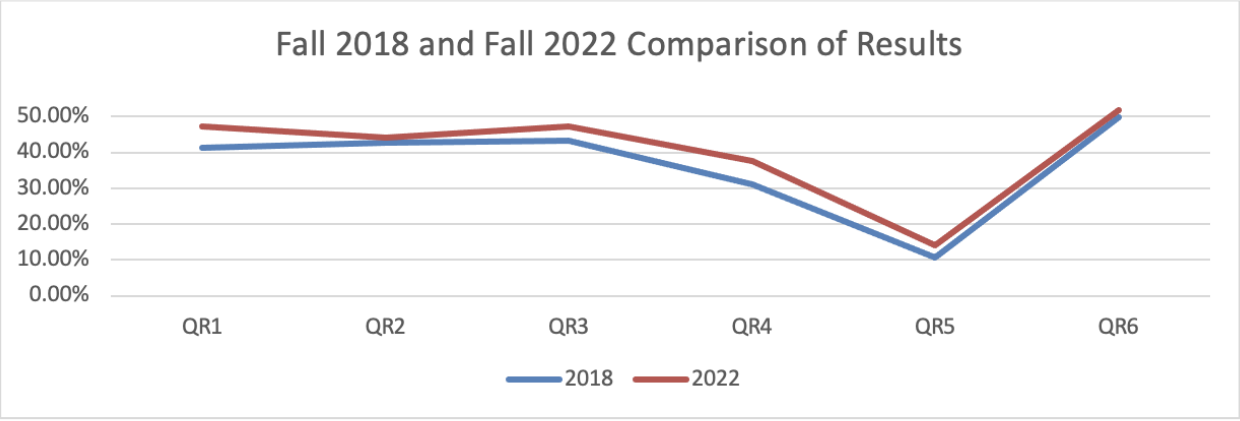


*Figure 2. Percentage of Artifacts Scored at 4 or 3 from 2018 and 2022*

**Inter-rater Reliability**

Three separate readers assessed each student artifact. Table 4 displays the mean score for the three separate readings of all artifacts.

Table 4

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

| | Assessor 1 | Assessor 2 | Assessor 3 | Standard Deviation |
|---|---|---|---|---|
| QR1 | 2.59 | 2.46 | 2.15 | 0.23 |
| QR2 | 2.36 | 2.38 | 2.01 | 0.21 |
| QR3 | 2.41 | 2.39 | 2.28 | 0.07 |
| QR4 | 2.23 | 2.21 | 1.96 | 0.15 |
| QR5 | 1.66 | 0.96 | 0.18 | 0.74 |
| QR6 | 2.47 | 2.25 | 2.29 | 0.12 |

In addition to the descriptive statistics, Table 5 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 the either the same or within one performance level. Values for *Total Agreement* provided in Table 5 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 applicable" for the artifact that was treated as a 0 for the inter-rater reliability analysis since a *0* and "not applicable" 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). All measures, except for (QR5) assumptions, were at the excellent level (above .75). The agreement for QR5 was at the fair level, which can primarily be attributed to the large percentage of not applicable scores and challenges with finding work samples that explicitly ask students to address assumptions.

Table 5

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

| Competency Measure | Total Agreement | Agreement (within 1 level) | ICC | 95% Confidence Interval |
|---|---|---|---|---|
| QR1 | 21.0% | 74.4% | .82 | .78-.84 |
| QR2 | 23.1% | 74.9% | .80 | .76-.83 |
| QR3 | 24.9% | 84.4% | .80 | .77-.84 |
| QR4 | 22.3% | 76.4% | .79 | .75-.82 |
| QR5 | 20.3% | 40.3% | .41 | .30-.50 |
| QR6 | 23.1% | 73.8% | .77 | .73-.81 |

**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 Fall 2022.

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 Cardinal Core QR syllabi identified 90% of syllabi contained the new Cardinal Core QR student learning outcomes and the remaining 10% listed outcomes, however they were the old Mathematics outcomes from the previous General Education Program. Of the syllabi that had the new QR learning outcomes, 100% also provided the corresponding methods of assessment.

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 results of this assessment indicate progress in student performance on all Quantitative Reasoning (QR) measures from 2018 to 2022. Students continue to perform highest on interpretation, calculation, and communication, with slightly lower performance on application/analysis. Assumptions continued to have a high percentage of work samples scored as "not applicable" or "0".

During the collaborative training and rubric norming sessions, reviewers engaged in extensive discussion regarding the "assumptions" measure. The conclusion of that discussion was that the rubric is really asking for students to explicitly discuss assumptions. Among the training/rubric norming samples and then the samples included in the assessment, very few assignments request students address assumptions. In some cases, reviewers felt assumptions were implied in the way that students addressed problems and answered questions, however without explicit recognition or discussion of assumptions it created challenges in regard to validity and reliability in the application of the instrument. This was the only area where inter-rater reliability was not at an excellent level in the assessment of Fall 2022 work samples.

The Cardinal Core Curriculum Committee (CCCC), Assessment Subcommittee, will work with representatives from departments offering Quantitative Reasoning (QR) courses to determine if the low performance on assumptions can be addressed by including more assignments that explicitly ask students to address assumptions or determine if the AAC&U Quantitative Literacy rubric should be adapted to broadly address the application of assumptions instead of explicit discussion of assumptions.

References

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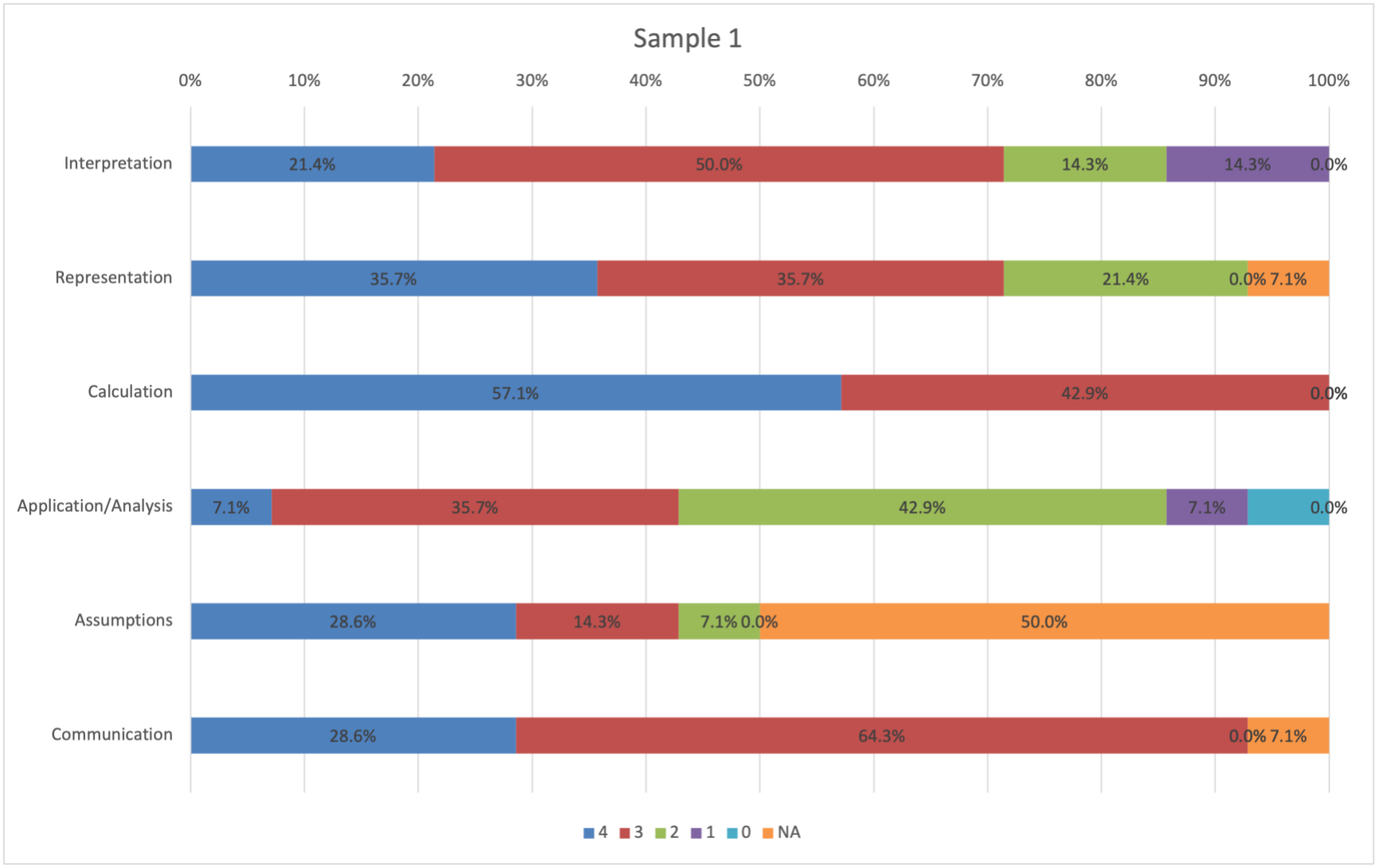
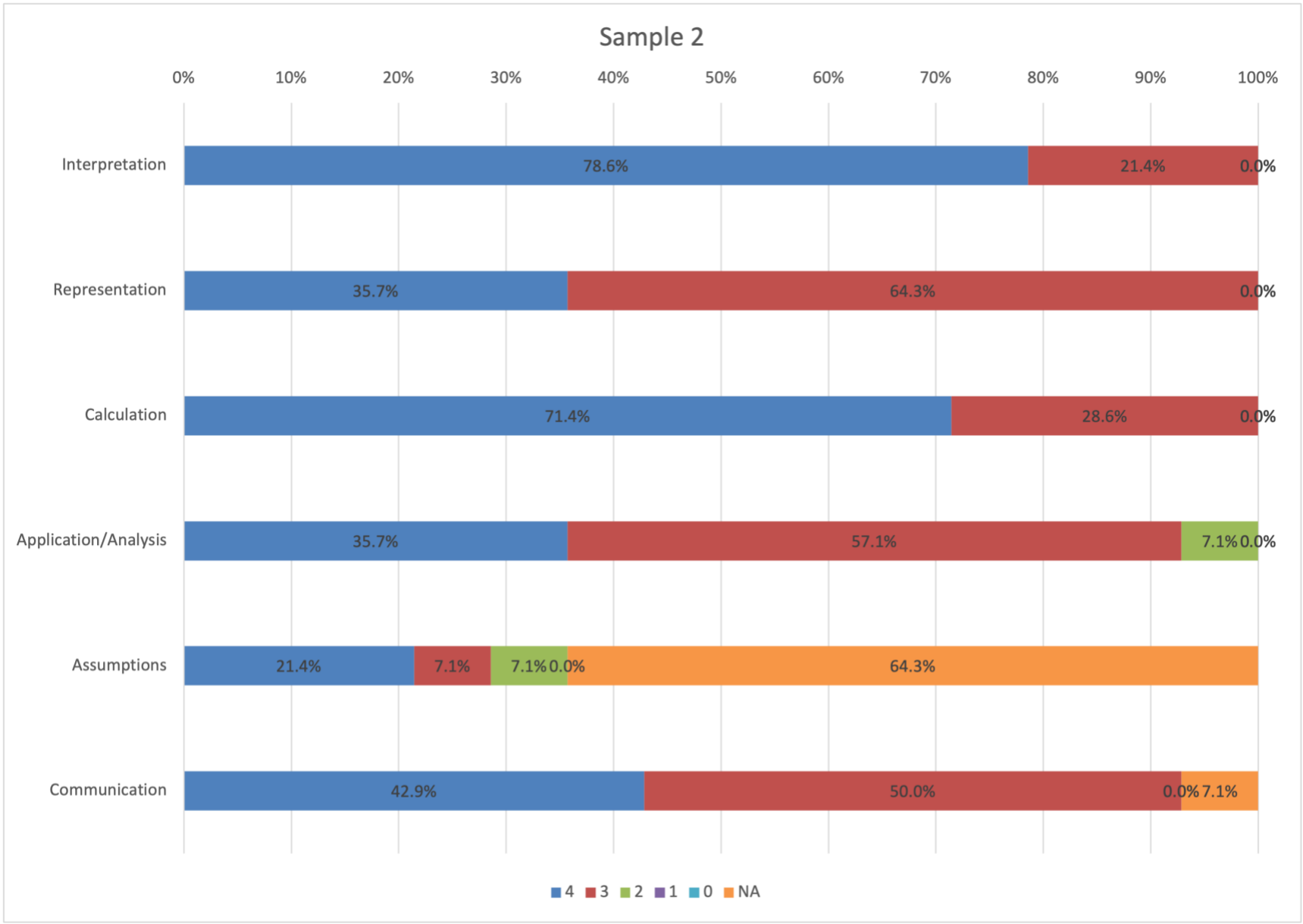
**Appendix A. Results from Assessment Training for Quantitative Reasoning**




Sample 2
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Interpretation
78.6%
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Representation
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64.3%
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Calculation
71.4%
28.6%
0.0%
Application/Analysis
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57.1%
7.1%
0.0%
Assumptions
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7.1%
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64.3%
Communication
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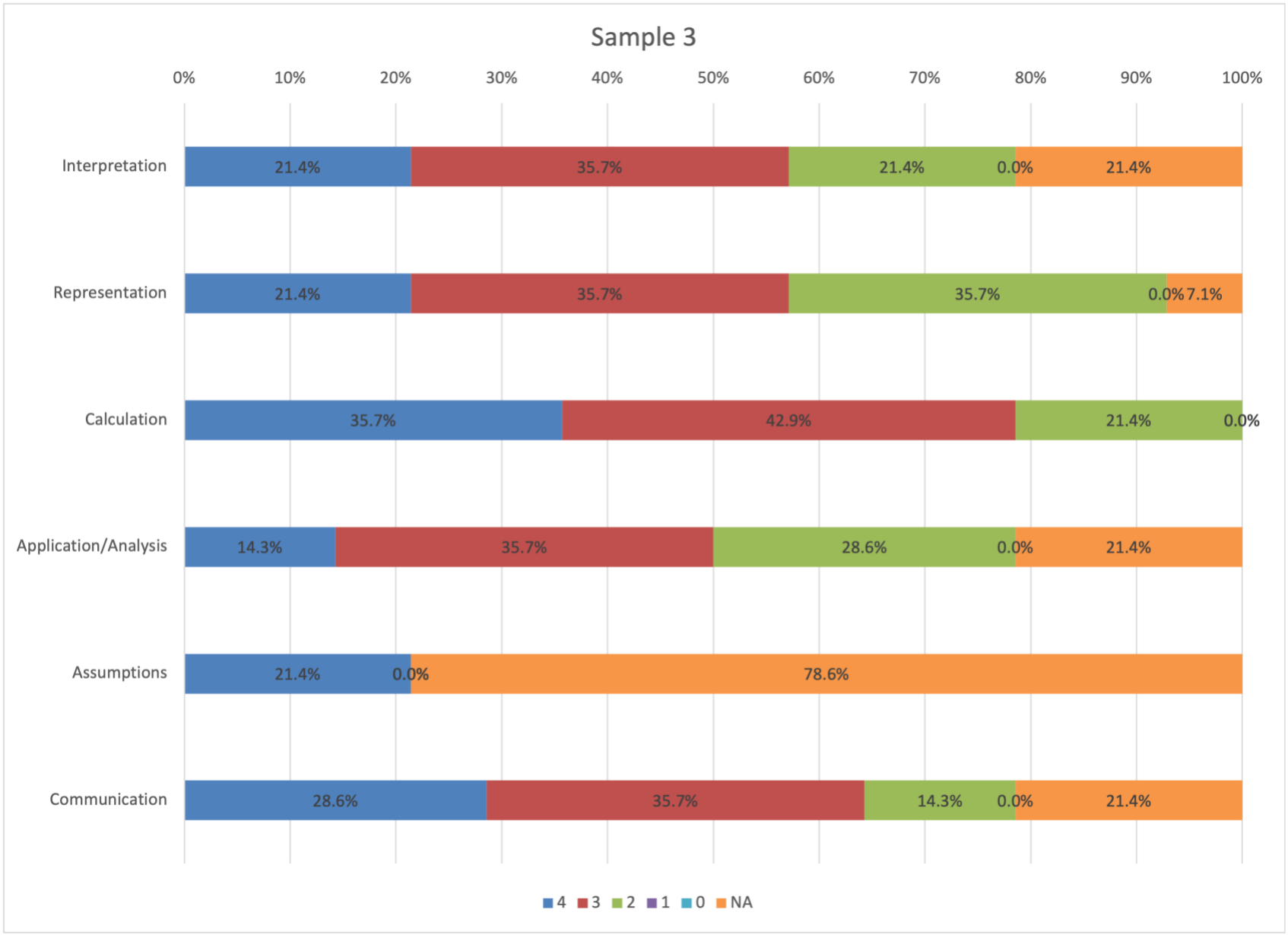
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Calculation
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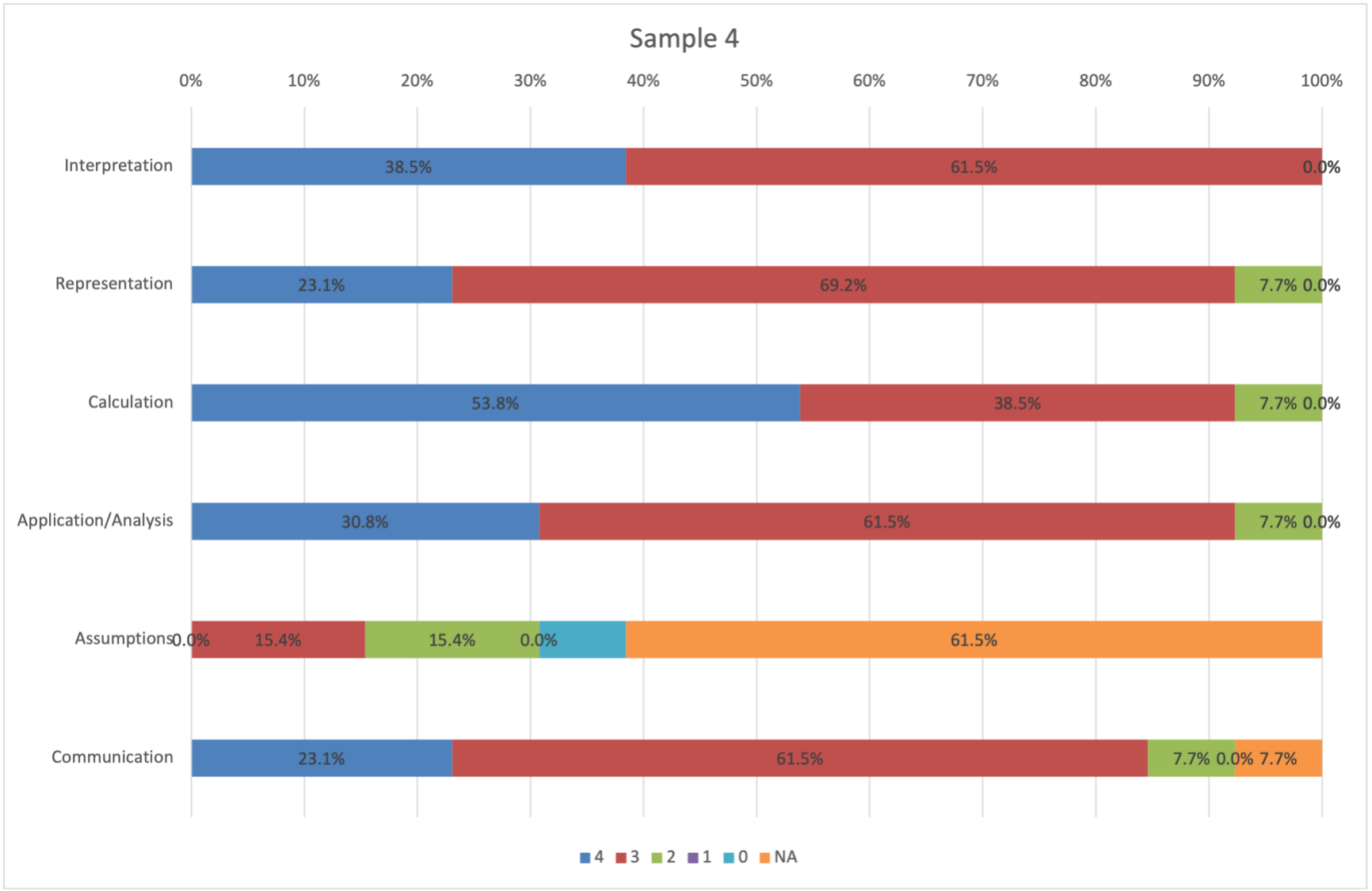
Sample 4
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Representation
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Calculation
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Application/Analysis
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Assumptions
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