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

Cardinal Core Assessment of Natural Sciences (Academic Year 2023-24)

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 at least two content areas each academic year and assessed by a panel of trained faculty. In 2023-24, the program's critical thinking competency was assessed in the Natural Sciences. The CCCC has designated the University of Louisville Natural Sciences Critical Thinking rubric as the instrument to measure the critical thinking competency as it pertains to the Natural Science Student Learning Outcomes.

The University of Louisville Outcomes, Kentucky Statewide Outcomes, and the Rubric Measures used to assess courses in the Natural Sciences content area are provided below.

University of Louisville Natural Sciences Learning Outcomes

Natural Sciences (S, SL, and B) are concerned with understanding the laws of nature and the physical world. Students who satisfy this requirement will be able to do all of the following:

1. Demonstrate an understanding of the nature and methods of science inquiry.
2. Apply scientific principles: to interpret evidence, to make predictions, and/or to explain cross-cutting concepts in one or more of the sciences.
3. Explain how scientific principles relate to issues of personal and/or societal importance.
4. Communicate effectively an understanding of scientific concepts and experimental outcomes in speech or writing, using sound scientific terminology and citation appropriate to the discipline.

Statewide Natural Sciences Student Learning Outcomes

1. Demonstrate an understanding of the methods of science inquiry.
2. Explain basic concepts and principles in one or more of the sciences.
3. Apply scientific principles to interpret and make predications in one or more of the sciences.
4. Explain how scientific principles relate to issues of personal and/or public importance.

University of Louisville Natural Sciences Critical Thinking Rubric

(NS1) Demonstrate an Understanding of Methods of Science
(NS2) Apply Scientific Principles
(NS3) Connecting Scientific Principles to Issues of Personal and/or Societal Importance
(NS4) Communicate an Understanding of Scientific Concepts and Experimental Outcomes

The Natural Sciences Rubric uses the same scoring categories as the AAC&U VALUE Rubrics to ensure consistency across all instruments used in the Cardinal Core Assessment, 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 meeting the rubric criteria.

Assessment Process

For the 2023-24 assessment of student work from the Natural Sciences (S, SL, and B) 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 all faculty teaching Cardinal Core S, SL, and B courses 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. Multiple follow-up communications were sent throughout the fall semester.

After the semester withdrawal deadline passed, the Cardinal Core Office retrieved the class rosters for all S, SL, and B Cardinal Core courses from the Office of the Registrar and selected a stratified random sample to ensure a representative sample of student work from across the Natural Sciences content area. Instructors of all S, SL, and B courses were sent a list of students selected for the assessment along with detailed instructions requesting that instructors provide a copy of one assignment along with the 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 and graduate teaching assistants assessed student artifacts. The University of Louisville Natural Sciences Critical Thinking Rubric 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 rubric, and scoring of benchmark sample assignments. Benchmarks were assignments selected to represent a wide range of content and skill development 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 during a collaborative meeting. Competency areas (rubric rows) with disagreement among reviewers were discussed in the findings shared with reviewers to clarify intended applications of the rubric. The results from scoring benchmark samples 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 Natural Sciences (S, SL, and B) Cardinal Core courses in Fall 2023 was approximately 7802 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 443 student work samples. The sample included work samples from Anthropology, Biology, Chemistry, Geography and Environmental Sciences, Health and Sport Sciences, Public Health, and Physics. 241 work samples came from lecture (S) courses, 161 work samples came from lab (SL) courses, and 41 work samples came from combined lecture/lab courses (B).

Summary of Assessment Data

For the assessment of Natural Sciences (S, SL, and B) outcomes, 443 student artifacts were assessed by faculty and graduate teaching assistants using the University of Louisville Natural Sciences Critical Thinking Rubric.

Table 1 provides the percentage of work samples scored at each rubric level for the Natural Sciences Critical Thinking Rubric. Assessors were given the 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. A calculation of the percentage of students who scored at a *3* or *4 (after any not applicable ratings were removed)* is also included from both 2020-21 and 2023-24 assessments to provide a comparison of student performance.

Table 1

Percentage of Artifacts Scored at Each Rubric Level for Natural Sciences

	NS1	**NS2**	**NS3**	**NS4**
Capstone (4)	24.0%	21.8%	20.1%	19.0%
Milestone (3)	33.3%	29.6%	21.9%	24.8%
Milestone (2)	26.3%	23.3%	15.9%	28.1%
Benchmark (1)	11.4%	8.9%	7.4%	12.5%
(0)	1.4%	1.9%	1.7%	1.2%
Not Applicable (NA)	3.5%	14.6%	33.0%	14.4%
***%Scored at 4 & 3 (2023-24)**	59.4%	60.2%	62.6%	51.1%
***%Scored at 4 & 3 (2020-21)**	56.4%	59.9%	46.2%	47.7%

*Not Applicable scores were removed for calculating the % of students scoring at 4 or 3.

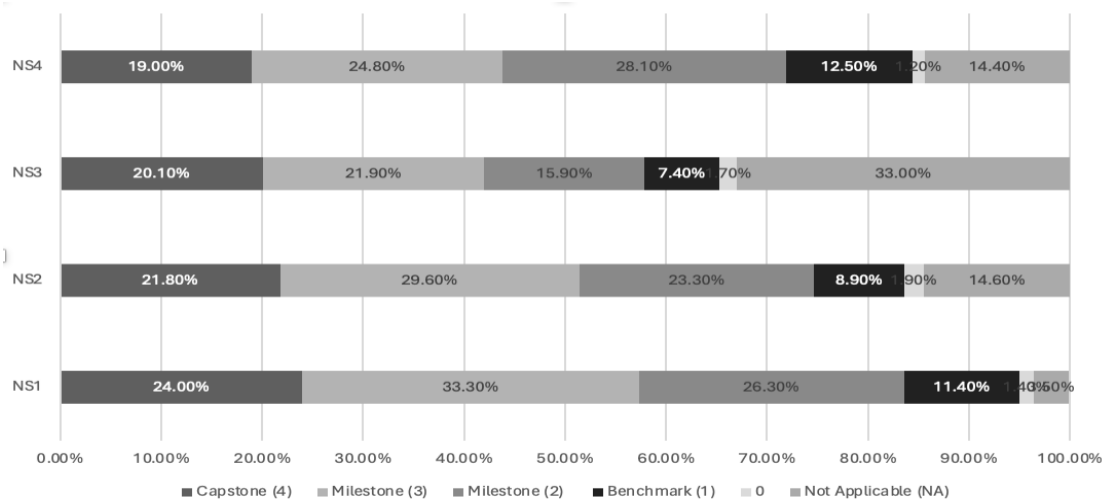

Figure 1. Percentage of Artifacts Scored at Each Rubric Level for Natural Sciences

Table 2 and Figure 2 provide a breakdown of the N/A ratings by S, SL, and B courses.

Table 2

Percentage of Not Applicable Scores by S, SL, and B Courses

	NS1	NS2	NS3	NS4
S	3.7%	20.9%	37.6%	22.5%
SL	3.3%	2.7%	30.6%	5.2%
B	3.3%	24.4%	14.6%	2.4%

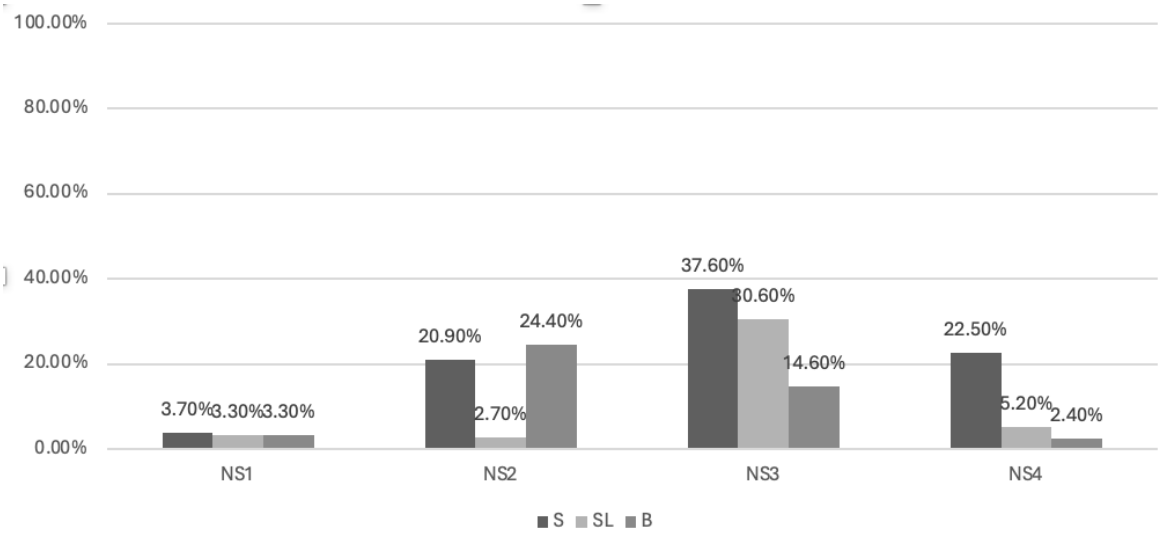

Figure 2. Percentage of Not Applicable Scores by S, SL, and B Courses

Table 3 provides a comparison of N/A ratings from the 2020-21 assessment to the 2023-24 assessment.

Table 3

Percentage of Artifacts Scored as Not Applicable from Fall 2020 Sample and Fall 2023 Sample

	NS1	NS2	NS3	NS4
% Not Applicable (2020-21)	5.0%	24.2%	46.3%	24.6%
% Not Applicable (2023-24)	3.5%	14.6%	33.0%	14.4%

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 4.

Table 4

Mode of Individual Work Sample Scores

	Mode
NS1 – Demonstrate an Understanding of Methods of Science	3
NS2 – Apply Scientific Principles	2
NS3 – Connecting Scientific Principles to Issues of Personal and/or Societal Importance	2
NS4 – Communicate an Understanding of Scientific Concepts and Experimental Outcomes	3

Distance Education Courses

For further understanding of student performance we sought to determine if there were any significant differences between student performance from face-to-face versus distance education courses, using the average of student overall scores for each rubric measure.

A multivariate test (MANOVA) revealed that there was a statistically significant difference in performance on rubric measures based on distance education vs face-to-face courses, [$F(4,443)= 8.23$, $p < .05$; Wilk's $\Lambda = .929$]. To determine how the results for these measures differ by group the tests of between subjects revealed statistically significant differences for NS2 and NS3 ($p<.05$). For NS2, face-to-face courses had a higher average rating and for NS3, distance education courses had a higher average rating.

Table 5

Mean for University of Louisville Cardinal Core Rubrics by Course Delivery Mode

	Face-to-Face Courses	Distance Education Courses
NS1	2.75	2.62
NS2*	2.48	2.10
NS3*	1.78	2.06
NS4	2.20	2.24

Inter-rater Reliability

Three separate readers assessed each student artifact. Table 6 displays the mean score for the three separate readings of all artifacts.

Table 6

Inter-rater Summary for University of Louisville Natural Sciences Critical Thinking Rubric

	Assessor 1	Assessor 2	Assessor 3	Standard Deviation
NS1	2.53	2.56	2.70	0.09
NS2	2.54	2.01	2.39	0.27
NS3	2.08	1.53	1.94	0.28
NS4	2.04	2.05	2.49	0.26

In addition to the descriptive statistics, Table 7 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 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 7

Inter-rater Reliability for University of Louisville Natural Sciences Critical Thinking Rubric

Competency Measure	Total Agreement	Agreement (within 1 level)	ICC	95% Confidence Interval
NS1	19.2%	68.2%	0.72	.67-.76
NS2	18.5%	56.9%	0.69	.63-.73
NS3	20.8%	44.5%	0.66	.60-.71
NS4	20.5%	58.5%	0.78	.74-.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 this review, the Cardinal Core Office collected all Natural Sciences (S, SL, and B) syllabi that were loaded to Blackboard in Fall 2023.

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?

The syllabus review included syllabi from 135 S, SL, and B Cardinal Core course sections offered in the Fall of 2023. The review of 135 syllabi identified 129 syllabi (97.0%) containing the Natural Science Cardinal Core learning outcomes approved for the course. Further review of the syllabi revealed that 114 syllabi (84.4%) 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

For critical thinking in the Natural Sciences, the percentage of students scoring at the highest two performance levels of the rubric increased for all four Natural Science rubric measures from the 2020-2021 assessment. There were also fewer "Not Applicable" ratings on all rubric measures. Of the four Natural Science competencies, communicating an understanding of scientific concepts and experimental outcomes (NS4) had the lowest percentage of samples scored at the highest two performance levels.

Connecting scientific principles to issues of personal and/or societal importance (NS3), consistent with results from 2020-2021, had the highest percentage of work samples scored as "Not Applicable" indicating that approximately one-third of samples did not ask students to demonstrate this Natural Sciences outcome. A higher percentage of "Not Applicable" ratings was expected for NS4 (Communicate an Understanding of Scientific Concepts and Experimental Outcomes) due to the lack of written work in some of the large lecture courses approved for Cardinal Core with the caveat that outcome 4 (NS4) would be met in the corresponding lab course. As shown in Table 2 and Figure 2, science lecture (S) courses account for approximately 75% of the N/A ratings for NS4.

While there were some significant differences in work sample scores for applying scientific principles (NS2) and connecting scientific principles to issues of personal and/or societal importance (NS3) between distance education and face-to-face courses, distance education samples were the higher performing samples for NS3 and the lower performing samples for NS2. These findings do not indicate that there is one mode of instruction that consistently results in better learning outcomes.

The results of this assessment are intended to help drive program improvement and support student growth. Faculty are encouraged to continue to emphasize building these competencies within their courses.

References

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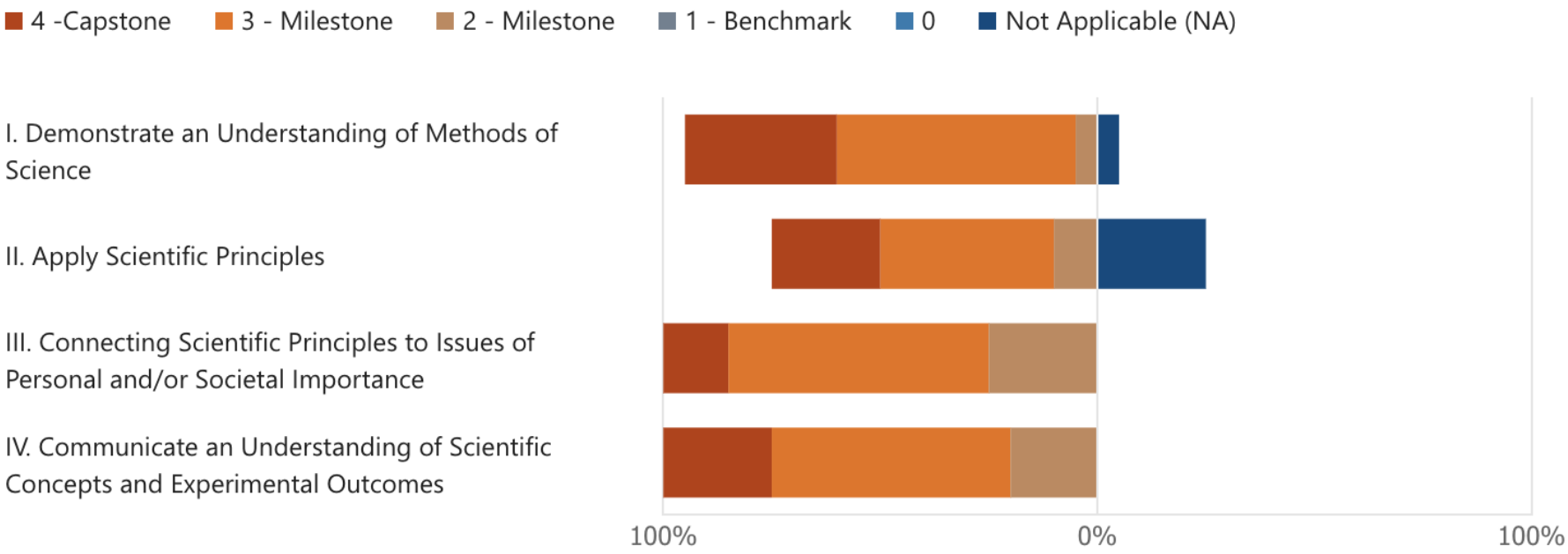
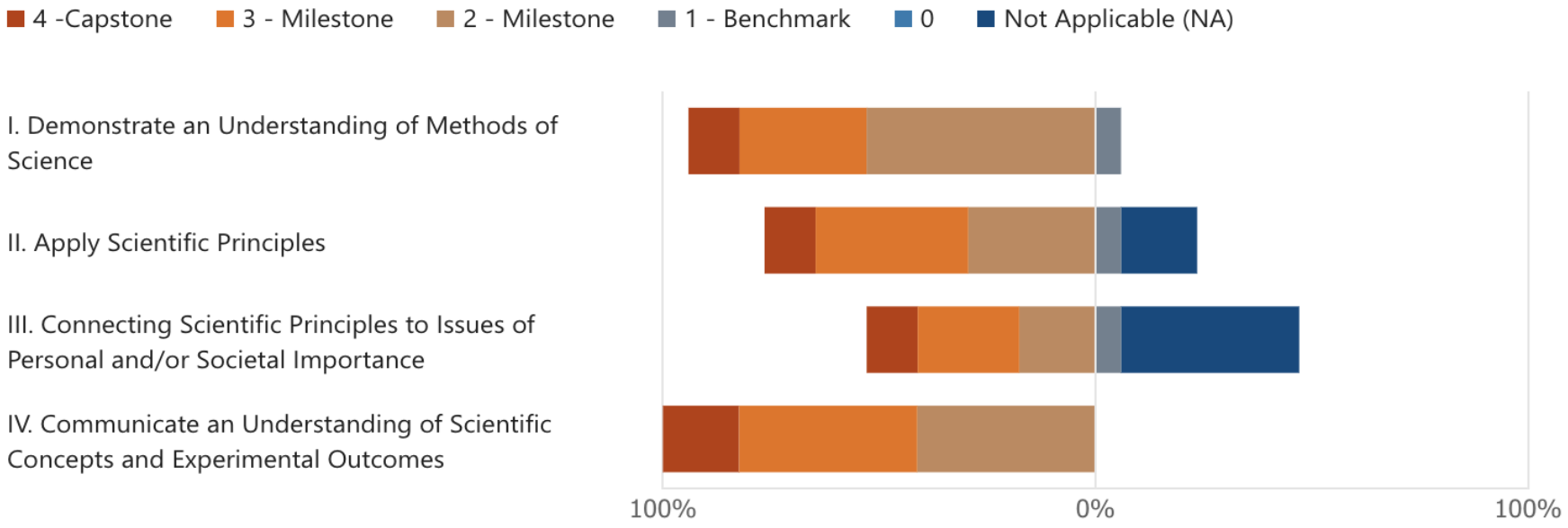
Appendix A. Results from Assessment Training for University of Louisville Natural Sciences Critical Thinking Rubric

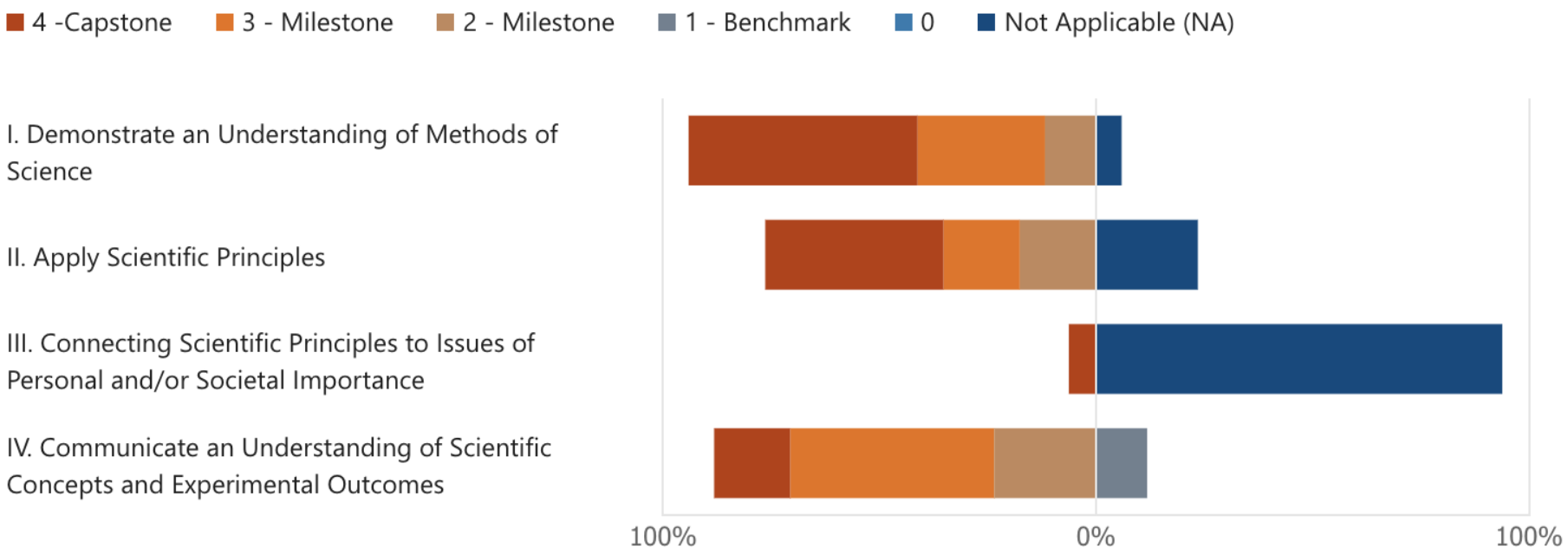
Sample 1



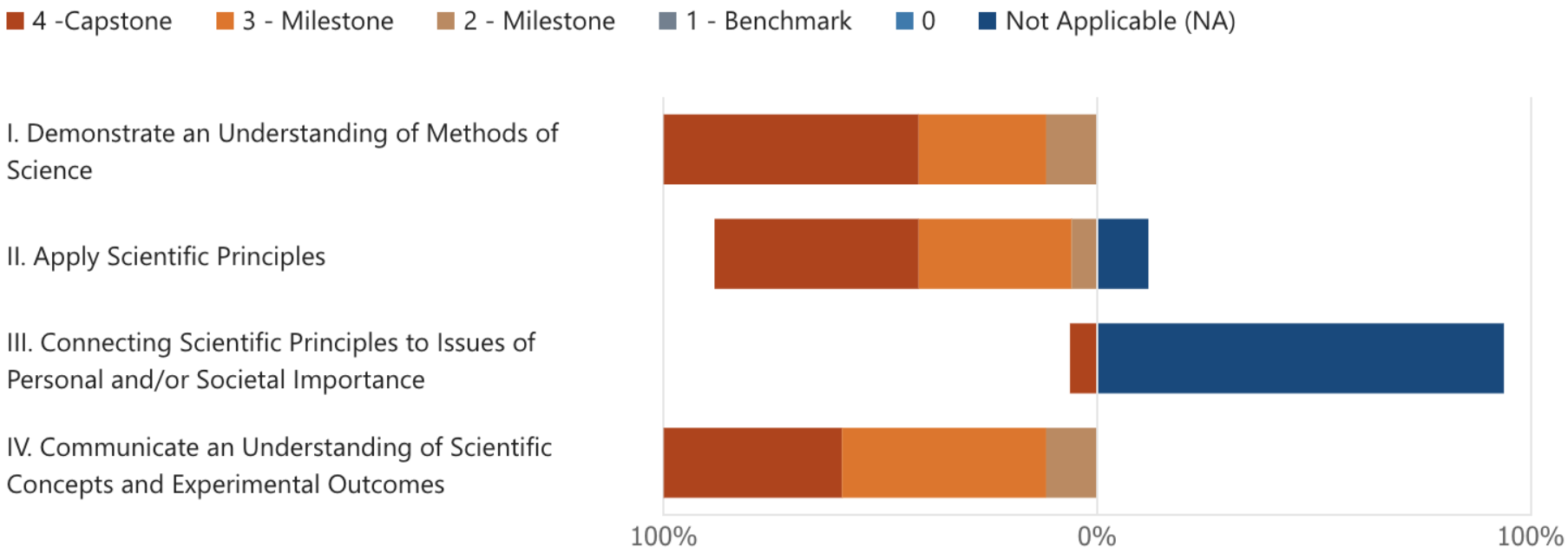
Sample 2


4 -Capstone
3 - Milestone
2 - Milestone
1 - Benchmark
0
Not Applicable (NA)
I. Demonstrate an Understanding of Methods of Science
II. Apply Scientific Principles
III. Connecting Scientific Principles to Issues of Personal and/or Societal Importance
IV. Communicate an Understanding of Scientific Concepts and Experimental Outcomes
100%
0%
100%

Sample 3


4 -Capstone
3 - Milestone
2 - Milestone
1 - Benchmark
0
Not Applicable (NA)
I. Demonstrate an Understanding of Methods of Science
II. Apply Scientific Principles
III. Connecting Scientific Principles to Issues of Personal and/or Societal Importance
IV. Communicate an Understanding of Scientific Concepts and Experimental Outcomes
100%
0%
100%

Sample 4


4 -Capstone
3 - Milestone
2 - Milestone
1 - Benchmark
0
Not Applicable (NA)
I. Demonstrate an Understanding of Methods of Science
II. Apply Scientific Principles
III. Connecting Scientific Principles to Issues of Personal and/or Societal Importance
IV. Communicate an Understanding of Scientific Concepts and Experimental Outcomes
100%
0%
100%