Example 1 - Natural Sciences at the University of Maryland

Part of a 4-area general education:

<table>
<thead>
<tr>
<th>Fundamental Studies</th>
<th>Distributive Studies</th>
<th>Diversity</th>
<th>Signature Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Writing (FSAW)</td>
<td>History and Social Sciences (DSHS)</td>
<td>Cultural Competency (DVCC)</td>
<td>I-Series (SCIS)</td>
</tr>
<tr>
<td>Analytic Reasoning (FSAR)</td>
<td>Humanities (DSHU)</td>
<td>Understanding Plural Societies (DVUP)</td>
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<tr>
<td>Math (FSMA)</td>
<td>Natural Sciences (DSNS)</td>
<td></td>
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<tr>
<td>Oral Communications (FSOC)</td>
<td>Natural Science Lab (DSNL)</td>
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<tr>
<td>Professional Writing (FSPW)</td>
<td>Scholarship in Practice (DSSP)</td>
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</table>

Courses in the Natural Sciences introduce students to the concepts and methods of the disciplines studying the natural world. It includes courses in the traditional physical and life sciences, environmental science, animal and avian science, and plant science, among others. It also includes a substantial, rigorous laboratory experience.

Courses in the Natural Sciences must address at least 4 of the 6 Learning Outcomes.

Learning Outcomes in **bold** are **required**.

On completion of a Natural Sciences course, students will be able to:

- Demonstrate a broad understanding of scientific principles and the ways scientists in a particular discipline conduct research.
- Apply quantitative, mathematical analyses to science problems.
- Solve complex problems requiring the application of several scientific concepts.
- Look at complex questions and identify the science and how it impacts and is impacted by political, social, economic, or ethical dimensions.
- Critically evaluate scientific arguments and understand the limits of scientific knowledge.
- Communicate scientific ideas effectively.

In addition to the Learning Outcomes above, on completion of a Natural Sciences course with a laboratory experience students will be able to:

- **Demonstrate proficiency in experimental science by:** making observations, understanding the fundamental elements of experiment design, generating and analyzing data using appropriate quantitative tools, using abstract reasoning to interpret data and relevant formulae, and testing hypotheses with scientific rigor.

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Examples 2 & 3
Both the University of Kentucky and Indiana University use two common student learning outcomes for their “cornerstone” courses that all students take (math, science, arts/humanities, social sciences).

Example 2 – Learning Outcome I: Intellectual Inquiry

- Students will demonstrate an understanding of and ability to employ the processes of intellectual inquiry.

Rubric specific to natural sciences:

<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
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</thead>
<tbody>
<tr>
<td><strong>Explore multiple and complex answers to questions/issues within the natural, physical and/or mathematical sciences by identifying the dimensions of a good question</strong></td>
<td>The question is described clearly, completely, fully and in great detail.</td>
<td>The question is described but some detail is missing.</td>
<td>The question is inadequate or incompletely described.</td>
<td>The question is absent and the experimental design is missing.</td>
</tr>
<tr>
<td>The question is answerable by experiment or observation.</td>
<td>The question is not answerable by experiment or observation but lacks clarity.</td>
<td>The question is not answerable by experiment or observation.</td>
<td>The experimental design is missing.</td>
<td></td>
</tr>
<tr>
<td>The experimental design is appropriate and described in detail.</td>
<td>The experimental design is inappropriate but lacks detail.</td>
<td>The experimental design is inappropriate.</td>
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</tbody>
</table>

| **Explore multiple and complex answers to questions/issues within the natural, physical and/or mathematical sciences by evaluating theses and conclusions in light of credible evidence; and judging the quality of information as informed by rigorously developed evidence** | Provides a well-developed evaluation and analysis of the data and questions its accuracy, relevance, and completeness. | Evaluation and analysis of data contains minor errors/omissions. | Evaluation and analysis of data contains major errors/omissions. | Evaluation and analysis of data is missing. |
| Justifies key results and procedures, explains assumptions and reasons. | Justifies some results or procedures, explains reasons. | Justification of results contains significant flaws. | No justification of results. |

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2 University of Kentucky. [http://www.uky.edu/registrar/content/uk-core](http://www.uky.edu/registrar/content/uk-core)
Example 3 Student Learning Outcomes for “Scientific Ways of Knowing”

- Access, use, and critically evaluate a variety of information sources.
- Apply principles of inquiry to define and analyze complex problems through reasoning and discovery.

Upon completion of inquiry in scientific ways of knowing, students will be able to:
  - Upon completion, students will be able to:
  - Explain how scientific explanations are formulated, tested, and modified or validated.
  - Distinguish between scientific and nonscientific evidence and explanations.
  - Apply foundational knowledge and discipline-specific concepts to address issues or solve problems.
  - Apply basic observational, quantitative, or technological methods to gather data and generate evidence-based conclusions.
  - Use current models and theories to describe, explain, or predict natural phenomena.
  - Locate reliable sources of scientific evidence to construct arguments related to real-world issues.

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Example 4 – Revising Student Learning Outcomes

“The 1997 Campus Learning Objectives were written by faculty, for faculty. The two examples below illustrate high aspirational goals with no clear path for attaining them within the university:

1. Educated persons should develop the skills to understand, accept, and relate to people of different backgrounds and beliefs. In a pluralistic world one should not be provincial or ignorant of other cultures; one’s life is experienced within the context of other races, religions, languages, nationalities, and value systems.
2. Educated persons should be expected to have some understanding of and experience in thinking about moral and ethical problems. A significant quality in educated persons is the ability to question and clarify personal and cultural values and thus be able to make discriminating moral and ethical choices.

The new Campus Learning Outcomes are written purposefully in a clear and concise language, which helps students understand expectations of them:

1. Communicate clearly and effectively in written and oral forms
2. Access, use, and critically evaluate a variety of relevant information sources
3. Apply principles of inquiry to define and analyze complex problems through reasoning and discovery
4. Demonstrate the ability to relate within a multicultural and digitally connected world
5. Demonstrate a deep understanding of a field of study

Each new outcome comes with an explanatory paragraph to provide clarity, which helps faculty members, students, and stakeholders better understand the intent of each outcome. It is clear that the new outcomes are simpler, streamlined, and easier to assess compared with the old objectives.”

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