

## GETSI Curriculum Development and Refinement Rubric

Geoscience literacy involves context that includes recognizing life situations involving geosciences and knowledge, and which encompasses understanding of both scientific concepts and the nature of science. It also includes competencies related to identifying scientific issues, explaining phenomena, and drawing scientific conclusions. Another component of literacy is associated with citizen attitudes related to indicating an interest and motivation to act responsibly toward the Earth.

This rubric is designed to guide GETSI curriculum developers as they create modules to improve geoscience literacy. The 28 elements are largely from [InTeGrate rubric](#) version 6 (with only minor wording changes such as to say “geodesy” instead of “geoscience”, removing of references to “courses” (modules-only), and more consistent usage of terms “goals” and “outcomes”). The largest departure is the 5th Guiding Principle. GETSI emphasized quantitative skills whereas InTeGrate focuses on systems thinking. The rubric incorporates broad goals of the InTeGrate project and researched guidelines for best practices in curriculum development and data-use and quantitative reasoning elements emphasized in the GETSI grant. The evaluation scheme is divided into six sub-areas:

1. Guiding principles
2. Learning objectives and goals
3. Assessment and measurement
4. Resources and materials
5. Instructional strategies
6. Alignment

The six sub-areas have a total of 28 elements that are equally weighted at 3 points each and are evaluated using the following scoring scheme:

- **3 points:** rubric element explicitly and/or pervasively addressed in module materials
- **2 points:** rubric element addressed in majority of the module materials
- **1 points:** rubric element addressed in some of the module materials
- **0 points:** rubric element not addressed in the module materials

A score of 15/15 must be achieved on the guiding principles portion of the rubric. Scores of 83% or higher must be achieved in each of the other sub-areas of the materials rubric. Materials meeting the above criteria will earn a minimum score of 74/84.

## Guiding Principles (must score 15/15)

- 1 **Module addresses one or more geoscience-related grand challenges facing society:** Grand challenges listed in the original GETSI proposal include geohazards, climate change, and water resources management. These and other challenges are described in detail in the *A Foundation for Innovation: Grand Challenges in Geodesy* ([http://www.unavco.org/pubs\\_reports/geodesy\\_science\\_plan/GrandChallengesInGeodesy-Final-Singles-LR.pdf](http://www.unavco.org/pubs_reports/geodesy_science_plan/GrandChallengesInGeodesy-Final-Singles-LR.pdf))
- 2 **Module develops student ability to address interdisciplinary problems:** Interdisciplinary problems require diverse perspectives that promote understanding of the interactions between Earth science and economic, societal and policy issues. Such materials integrate robust geoscience with trans-disciplinary knowledge from other disciplines such as geography, social sciences and humanities.
- 3 **Module improves student understanding of the nature and methods of geoscience and developing geoscientific habits of mind:** Geoscience is a discipline based on making observations of the Earth and testing hypotheses about Earth's history and processes against those observations. The methods of geoscience include: comparing modern processes to those found in the geologic record; comparison of cases to understand commonalities and differences attributable to process, history, and context; developing converging lines of evidence; and testing through prediction. Geoscientific habits of mind include: recognition of the fundamental role of observation and of a spatial and temporal organizational scheme in understanding the Earth, recognition of the Earth as a long-lived, dynamic, complex system whose history is shaped by a continuum of long-lived low impact processes and short-duration high impact processes, and valuing collaboration as a strategy for effectively moving forward understanding of the Earth.
- 4 **Module makes use of authentic and credible geodesy data to learn central concepts in the context of geoscience methods of inquiry:** Curricular materials use the most appropriate data available for the topics under discussion. Large amounts of data that address societal problems are available with increasing frequency and resolution. For instance, geoscientists use such data to derive and inform knowledge, to develop hazard assessments, to provide early warning to citizens and as inputs to models. References to updated data sources will be provided as available.
- 5 **Learning strategies and activities support quantitative problem solving:** Promote mastery of skills or strategies that are central to solving authentic geoscience problems. Assist students in recognizing when the skill or strategy is likely to be applicable to a problem. Draw attention to the types of strategies that are being used to check for progress toward the solution both in the specific (answer verification) and in the abstract (evaluation of need to switch to a different approach to the problem). Instill students with the confidence needed to approach and solve a quantitative problem.

## Learning Goals and Outcomes (must score 13/15)

- 6 **Learning outcomes describe measureable geoscience literacy goals:** Learning outcomes are clear statements that describe the desired goals of the instruction. Learning outcomes are directly stated specific competencies, skills and/or knowledge that students

are to master or demonstrate. The objectives and goals are directly linked to one or more sub-points of the major big ideas published in the Earth Science, Climate, Ocean and/or Atmosphere literacy documents where appropriate.

**7 Instructions and/or rubrics provide guidance for how students meet learning goals:** Rubrics are developed that provide the student a clear indication of the performance conditions and standards necessary to meet learning goals. If this specificity is not possible (e.g. internal cognition, affective changes), metrics used to measure indications of such change must be described for the student.

**8 Learning goals and outcomes are appropriate for the intended use of the module:** Lower-division courses should address content mastery, critical thinking skills, and core learning skills related to introducing guiding principles. Upper-division and graduate courses may focus on advanced guiding principles related to global interdisciplinary problems.

**9 Learning goals and outcomes are clearly stated for each module in language suitable for the level of the students:** Learning goals and outcomes should avoid jargon and highly technical language unless required.

**10 Learning goals and outcomes address the process and nature of science and development of scientific habits of mind:** According to the AAAS, the process of science and scientific inquiry (or habits of mind) include the notions that science demands evidence, science is a blend of logic and imagination, science explains and predicts, scientists attempt to avoid bias, and there are accepted criteria for evaluating the credibility of data. The nature of science includes such attributes as: the world is understandable, recognizing the difference between credible and non-credible scientific arguments, scientific ideas are subject to change, scientific knowledge is long-lasting or durable but subject to change and science cannot answer all questions. Scientific habits of mind include recognition that science is a complex social activity, science is organized by disciplines and carried out at multiple institutions, there are accepted ethical principles related to the conduct of science, scientists participate in public affairs as specialists and citizens, scientists communicate their understanding of the world to multiple audiences, and that there are accepted criteria for evaluating the credibility of scientific interpretations and scientific claims.

## Assessment and Measurement (must score 13/15)

**11 Assessments measure the learning goals:** Embedded formative assessments and summative assessments and assignments will provide logical tools to determine the extent to which students have met the module goals. These activities must match course content such that they help the student achieve the goals (and thus be able to do the assignments).

**12 Assessments are criterion referenced:** Assessments include a clear and meaningful list of criteria used to evaluate student work and participation including all the information students need to know how a grade will be calculated. This could be accomplished with a formal rubric or with a more informally structured description of what each grade looks like. This could involve a rubric for each type of assignment, a list of

criteria and associated point values for specific assignments or a sample of acceptable or unacceptable student work such as examples of excellent or poor papers or projects.

**13 Assessments are consistent with module activities and resources expected:** Assessments and assignments should support module activities and be designed to measure the extent to which the student has accomplished one or more of the goals. Every assignment should link directly to the goals assessed. Resources needed for activities and assessments are clearly stated.

**14 Assessments are sequenced, varied and appropriate to the content:** The sequence and schedule or pace of the assessments match the content. Assessments should vary in type and duration and can build on previously acquired knowledge within the or in prerequisite courses.

**15 Assessments address goals at successively higher cognitive levels:** If appropriate, assessments progress from lower level knowledge recall and understanding to higher order thinking, application of knowledge and even knowledge creation. Feedback from these assessments informs the student of their level of learning.

## Resources and Materials (must score 15/18)

**16 Instructional materials contribute to the stated learning outcomes:** Course materials such as textbooks, monographs, articles, lecture notes, audio or video recordings, games, or websites should directly support one or more guiding principles, literacy goals or core concepts embedded in learning goals and outcomes.

**17 Students will recognize the link between the learning outcomes, goals and the learning materials:** Curriculum should be designed such that students can recognize the purpose of all content, materials, resources, technologies, and instructional methods used in the course; how each resource helps them achieve the stated learning goals; and which materials are required and which are recommended resources. Reviewers will assess whether they believe the students will understand how to use the materials provided.

**18 Instructional materials should be sufficiently diverse and at the depth necessary for students to achieve learning goals and outcomes:** Instructors should provide meaningful content using a variety of sources (e.g., text, articles, presentations, websites, lecture notes, outlines, and multimedia). The course materials are robust and create a rich learning environment for students. The level of detail in supporting materials is appropriate for the level of the course, and provides depth sufficient for students to achieve the learning goals. For example, an upper-level capstone course should include significantly deeper materials than those required for an introductory general education course.

**19 Materials are appropriately cited:** All learning materials, software and learning resources must conform to copyright law and proper citation protocols unless there is a specific statement attached to the materials stating that they are in the public domain.

**20 Instructional materials are current:** The materials represent up-to-date thinking and practice in the discipline.

**21 Instructional materials and the technology to support these materials are clearly stated:** If specific technology is needed, what is required is clearly stated, e.g. computer lab with licenses to a specific software application.

### Instructional Strategies (must score 13/15)

**22 Learning strategies and activities support stated learning goals and outcomes:** The learning activities promote the achievement of the stated learning goals and outcomes. Students should be able to meet the stated goals using the learning activities provided. They should actively engage students with the course content using a variety of different types of activities. Activities should be designed to support reinforcement and mastery in multiple ways.

**23 Learning strategies and activities promote student engagement with the materials.** Activities should connect to personal experiences of students, motivate and engage students, connect to real world experiences, and build on what they know and address their initial beliefs. Activities should provide multiple opportunities that foster interactions designed to facilitate students' understanding and mastery of the learning objectives and goals. Activities should foster instructor-student, content-student and student-student interactions where appropriate. Examples include group discussions or blogs, small-group projects, peer critiques or rotating assigned communication roles such as moderator or summarizer.

**24 Learning activities develop student metacognition:** The activities should provide opportunities for students to iterate and improve their understanding incrementally. Activities should include an appropriate balance of guidance versus exploration and opportunities for reflection, discussion, and synthesis. Students should be able to assess their own learning and confirm they are on the right track.

**25 Learning strategies and activities provide opportunities for students to practice communicating geoscience:** It should be clear that the students will be engaged in independent thinking, problem solving, and communicating their understanding. Activities should challenge misconceptions, provide opportunities for students to practice judging what constitutes credible evidence and opportunities to practice effectively communicating geoscience concepts verbally and in writing where appropriate.

**26 Learning strategies and activities scaffold learning:** Activities should promote deep learning by stimulating student intellectual growth from novice to advanced levels, considering the needs of non-traditional students, as appropriate. Activities should be structured to allow students to first note obvious connections and then grasp the significance of those connections. At higher levels, students should be challenged to appreciate the significance of the parts as related to the larger concept and eventually extend those concepts to general principles outside the discipline.

### Alignment (must score 5/6)

**27 Teaching materials, assessments, resources and learning activities align with one another:** A constructive alignment approach suggests that goals, learning activities and

assessments within each section of the module align with one another and directly with stated learning objectives and goals. A curriculum map that identifies core skills and content, learning strategies and resources can be used as an effective way to ensure alignment.

28     **All aspects of the module are aligned:** An alignment approach suggests that curricular materials align directly with stated module goals holistically across the entire module.