APPENDIX 8: DEVELOPING ASSESSMENT RUBRICS IN SCIENCE

The Nature, Purposes, and Sources of Assessment Rubrics for Science

What Assessment Rubrics Are

Rubrics are assessment tools that identify criteria by which student processes, performances, or products will be assessed. They also describe the qualities of work at various levels of proficiency for each criterion.

The following types of assessment rubrics may be used in classroom assessment:

- **General rubrics** provide descriptions of proficiency levels that can be applied to a range of student processes, performances, or products. Using the same rubric for similar tasks helps teachers manage marking assignments based on student choice. It also helps students internalize the common qualities of effective processes, performances, and products.

- **Task-specific rubrics** describe the criteria used in assessing specific forms, such as using a balance, writing a laboratory report, or calibrating CBL probes. Complex student projects may require a different rubric for each phase (for example, a group inquiry project may require a rubric for collaborative work, information-gathering processes, oral presentations, and written reports).

- **Holistic rubrics** are used to assign a single mark to a process, performance, or product on the basis of its adequacy in meeting identified criteria.

- **Analytic rubrics** are used to assign individual scores to different aspects of a process, performance, or product, based on their specific strengths and weaknesses according to identified criteria. See the Rubric for Assessment of Decision-Making Process Activity in Appendix 9.

- **Checklists** are lists of criteria that do not distinguish levels of performance. They are used to assess the presence or absence of certain behaviours, and are most suitable for assessing processes (for example, "Did the student perform all the necessary steps?"). Because they require "Yes/No" judgements from the assessor, checklists are easy for students to use in peer assessment.

- **Rating scales** ask assessors to rate various elements of a process, performance, or product on a numerical scale. They do not provide complete descriptions of performance at various levels.

Why Teachers Use Assessment Rubrics

The best assessment tasks ask students to perform the sorts of scientific literacy tasks they will be called upon to perform in real-world situations. They allow students to demonstrate not only the declarative knowledge they have gained, but also the interplay of attitudes, skills, and strategies that constitute their learning. Authentic assessment tasks invite a range of responses and allow students to express their individuality. For all these reasons, assessing scientific literacy is a complex matter.

Assessment rubrics

- help teachers clarify the qualities they are looking for in student work
- ensure that all students are assessed by the same criteria
- help teachers communicate the goals of each assignment in specific terms
- allow teachers within schools, school divisions, and the province to collaborate in assessment
- play an important part in instruction

How Assessment Rubrics Enhance Instruction

The best assessment tools do not simply sort and score student work; instead, they describe it in specific terms. This assessment information

- helps teachers adjust instruction to meet student learning requirements
- tells students what teachers expect and will look for in their work, and helps them to focus their efforts
- allows students to assess their own work using the criteria teachers will use to set goals and to monitor their progress
- aids in the development of metacognition by giving students a vocabulary for talking about particular aspects of their work

Sources of Assessment Rubrics

Teachers develop assessment rubrics in collaboration with students, on their own, and/or with other teachers, or obtain them through published sources.

- **Classroom Development:** Developing assessment rubrics in collaboration with students can be a time-consuming process, but one that has many benefits in instruction and learning. (Both the benefits and the process are explored on the following pages.) Although it may not be possible to involve students in the process in every instance, their experience in developing rubrics will help students to use ready-made rubrics with more understanding.

- **Teacher-Developed:** Teachers develop general performance and product rubrics individually in collaboration within a school or school division. Rubrics must be adapted regularly to reflect student performance levels accurately.

  It is important that teacher-developed rubrics use language that students understand, and that teachers provide an example of work at each level of proficiency. These examples (called anchors or exemplars) illustrate for students the descriptive phrases used in the rubrics.

- **Published Sources:** High-quality assessment rubrics are available in various educational resources. The disadvantage of ready-made rubrics is that they may not be congruent with the learning outcomes targeted in a particular assignment, and may not accurately describe Senior 3 performance levels and criteria.

Developing Rubrics in Collaboration with Students

Student Benefits

Developing rubrics in collaboration with students requires them to look at work samples, and to identify the attributes that make some samples successful and others unsuccessful. Teachers assist students by providing them with the vocabulary to articulate the various elements they see, and by ensuring the criteria are comprehensive and consistent with learning outcomes. This collaborative process in developing rubrics

- requires students to make judgements about the work they see, and to identify the qualities of effective writing, speaking, and representing of science concepts
- results in an assessment tool that students understand and feel they own—they see that assessment criteria are not arbitrary or imposed, but rather express their own observations about what constitutes quality work

The Development Process

For their first experience in designing a rubric, ask students to articulate the criteria they use in making judgements about something in everyday life—the quality of a restaurant, for example. The model rubric that they develop for assessing restaurants may help students grasp how the parts of a rubric work.

Students may also find it helpful to develop rubrics after they have done some preliminary work on the assessment task, and so are familiar with the demands of the particular assignment.

The process of developing assessment rubrics in collaboration with students involves numerous steps.

1. *Look at student work samples.*

Develop assessment rubrics by analyzing genuine samples of student work that illustrate the learning outcomes that the assessment task in question addresses. Samples are usually drawn from student work from previous years, used with permission and with names removed. Beginning teachers who do not have files of samples may need to borrow from colleagues.

Select samples that are clear and characteristic of student work at various levels. Streamline the process by distributing examples at only three levels of proficiency: excellent, adequate, and inadequate. Provide two or three examples of each level. Allow students time to read the examples and to talk about them in groups.

2. *Describe the work samples.*

Suggest that students focus on the examples of excellent work first. Pose the question: "What makes this piece successful?" Then ask students to brainstorm attributes of, or criteria for, success. Some of the attributes students list will describe behaviours that are useful in meeting the goals of the work (for example, the topic is stated at the beginning, there are few spelling errors, a graph is used to represent statistical findings).

What rubrics must attempt to articulate, beyond identifying these behaviours, is the essence of a good product or performance. As Wiggins points out, eye contact may be important in the delivery of an oral report, but it is possible to give a dreary talk while maintaining eye contact (V1-5: 6). Together with students, identify the salient qualities of works related to science that are engaging and effective. These may be qualities that are harder to define and illustrate (for example, the speaker has moved beyond a superficial understanding of the subject, the producer of a video is aware of the audience, the writer's voice is discernible in a science journalism piece).

3. *Develop criteria categories.*

From the brainstormed list of attributes, select the criteria categories that will make up the assessment rubric. Most rubrics are limited to three to five criteria categories. A greater number makes the rubrics difficult for assessors to use, especially in assessing live performances. Listing too many criteria can also overwhelm or confuse students who use the rubrics for self-assessment and setting goals.

Develop criteria categories by combining related attributes and selecting three to five that are considered most important. Label the criteria categories in general terms (organization, style, content) and expand them by listing the specific elements to be examined in assessing quality in these criteria (for example, in the "organization" category, the elements may be statement of purpose, topic sentences, transition words and phrases, paragraph breaks, order of ideas).

Ensure that no essential attribute that defines good performance is left out. This means including elements considered hard to assess (such as style or creativity). Ignoring elements such as these signals that they are not important. Addressing them helps students grasp the things they can do to improve their own work in these areas. If graphical analysis is identified as one criteria category, for example, the rubric may list elements that convey the details of such an analysis (for example, placement of dependent and independent variables, placement of data points, line of "best fit"). It may also provide definitions.

As students collaborate to develop criteria categories, monitor whether the criteria chosen are related to the intended learning outcomes.

4. *Decide how many performance levels the rubric will contain.*

The first rubric students develop will have three performance levels, based on identifying student work samples as excellent, adequate, or inadequate. In later rubrics, students may move to finer distinctions between levels. The number of levels needed to make meaningful judgements regarding the full range of proficiency is best decided by the teacher. If the scale is large (seven levels, for example), finer distinctions can be made, but it may be difficult to differentiate clearly one level from the next. In science, assessment rubrics designed to be used by students as well as teachers generally use three, four, or five performance levels.*

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* Many designers of rubrics advocate a five-level scale. Levels 1, 3, and 5 are developed from an initial sorting of student work into excellent, adequate, and inadequate samples. Levels 2 and 4 describe work that is between these anchor points. Other educators argue that an even-point scale (four or six levels) forces more care in judging than an odd number does; it prevents assessors from overusing a middle category for work that is difficult to assess.

Using the same number of performance levels for various tasks throughout the curriculum has the advantage of giving students and the teacher a common vocabulary in talking about ways to improve performance (for example, "This piece does not have the concrete detail of level 4 writing."). Once the number of criteria categories and performance levels has been determined, a rubric template such as the following can be used in developing rubrics.

		Criteria Categories			
Performance Levels	1				
	2				
	3				
	4				
	5				

5. Describe the performance levels.

In developing the assessment criteria (Step 3), students analyze successful pieces of work. They now fill in descriptions of excellent, adequate, and inadequate performance in all criteria categories.

There are two ways of describing performance levels:
- **Evaluative rubrics** use comparative adjectives (for example, "weak organization").
- **Descriptive rubrics** specify the qualities of work at each performance level with respect to the criteria (for example, "unconnected ideas appear in the same paragraph"). The attributes listed may be negative (for example, "subscripts and coefficients are incorrectly applied"), for sometimes the most telling characteristic of certain levels is their failure to do what they should be doing.

Descriptive rubrics have many advantages over evaluative rubrics. They are more helpful to students because they spell out the behaviours and qualities students encounter in assessing their own and others' work. They also help students identify the things they can address in their own work in order to improve.

When beginning to write descriptive rubrics, students may suggest generally descriptive adjectives (such as "interesting," "boring"), which may not convey information about what an interesting piece looks like, and how they can improve their work in this area. The description needs to state the attributes that make a work interesting, and be written in an acceptable style for scientific communication. Classes may need to begin by using comparative language or general descriptions. As the students and teacher collect examples, they can fine-tune the rubric with specific descriptions.

By the end of this step, students will have a description of performance at three levels. If the class has decided to create a rubric with four, five, or six performance levels, it may be most efficient for the teacher to draft gradations of quality for the middle levels, and present them to the class for revision. These middle levels are the most difficult to write, and call on more experience and expertise in developing a smooth continuum of proficiency.

6. *Use the assessment rubric for student self-assessment, for teacher assessment, and for instruction.*

Before using the rubric on an actual assignment, students and the teacher may want to test it against unsorted samples of work from previous years. Applying the rubric to student work helps the class determine whether the rubric accurately describes the qualities of the work they see, and helps students make meaningful distinctions between work at different levels of proficiency. As students become more adept at using the rubric, and when they have internalized the performance levels, the teacher can present them with more diverse samples and assessment challenges.

Rubrics make it possible for students to assess their own work on the basis of the criteria that the teacher will use. Any differences in scores between a student's and a teacher's assessment can be the subject of profitable and focused discussion in student conferences.

If numerical scores are required, point values assigned to each level can be totalled. If the teacher and students decide that certain criteria categories should be more heavily weighted than others, the points assigned to these categories can be multiplied by a factor.

A rubric developed collaboratively can also become a valuable instructional tool, encouraging students to look closely at the specific things they can do to improve a piece of work. If students decide that a writing sample in science is at level 3, for example, they can be asked to work together in groups to improve the work so that it fits the description for level 4.

7. *Continue to revise the assessment rubric.*

Any assessment rubric can be considered a work in progress, especially if it is stored on the computer. Both the teacher and students should carefully review the rubric each time they use it, asking, "Do these criteria capture the most important qualities of excellence in this work?" "What other words and phrases can we use to describe work at this level?" In keeping with this, the rubrics appearing in Appendix 9 of this document are intended as templates, open to situational revisions.