PERFORMANCE ASSESSMENTS IN SCIENCE

Dr. Lourdes M. Ferrer
University of Guam, U.S.A.

Performance assessments are tasks associated with scoring schemes called *rubrics* that require students to produce something or perform in some way – by demonstrating, drawing and explaining a diagram, reasoning on a solution, designing a procedure, or constructing a project. The quality of output can be judged using a set of criteria contained in the rubrics. The rubrics for performance assessments consist of fixed scales related to a list of criteria describing performance. Each scale is composed of *anchors* that describe various levels of performance complexity (e.g. Very good, Good, Fair, Unsatisfactory).

Both process and output (product) are assessed. Following are examples of products and processes that can be assessed by rubrics.

1. Product – portfolios, research papers, experiment reports, projects, journals and reflections.
2. Process – interviews, oral presentations, creative performance, group interactions, and daily recitations

Product Assessment

1. Science Portfolio

A science portfolio is a collection of evidences that represents science learning within a given period of time. The evidences include the student's work, experiences and his/her reflections on those experiences. It may be used formatively as evidence of process and progress, or summatively as evidence of achievement of the learning goals of science instruction.

The content of a student science portfolio includes:

1. test papers
2. worksheets
3. experiment reports
4. projects – collage, inventions, creative work
5. drawings
6. pictures depicting activities undertaken
7. assignments

Every science teacher should encourage students to write their reflections about each content. Self-reflections of what understandings the piece of work demonstrates in each content is very important. For example, test results should be analyzed by students focusing on items they did not answer correctly. They should be made to write ways of improving their test scores. The students should

also be trained to respond to teacher feedback of their work samples that are included in the portfolio.

The rubric below may be used to assess the student science portfolio.

Criteria	V.G.	Good	Fair	N.I.
1. Content	All of the required contents (100%) are there	90% are there.	80% are there	70% or less are there
2. Reflections	Complete and substantial for all the contents	Substantial for most of the contents	Substantial for some of the contents	Incomplete and no substance at all.
3.Organization	Very well organized	Well organized	Somewhat organized	Not organized

2. Journals

They provide insights about a student's level of understanding. The following guide questions in writing the journal should be given to students.

- What have you learned in today's lesson?
- What difficulties did you encounter in learning about the lesson for today?
- How may you be helped in understanding the lesson better?

Journals can also provide information about the student attitude about the lesson or the subject itself. The following are questions that students can respond to when they write their journals.

- Did you like the lesson? Explain your answer.
- How can the lesson be made more interesting? or
- How can science be made more interesting

The types of journal entries are:

- Reports/products of an investigation or class activity
- Explanations of the processes used to solve a situational problem
- Responses to open-ended questions
- Definitions, concepts, and processes written in the students' own words
- Explanations of their own errors (self-correction)
- Expressions of their feelings about the learning experience
- Expressions of their thought processes about a lesson

3. Projects

Projects are outgrowths of lessons previously learned. They are applications of science concepts. Students should be encouraged to invent something (an artifact) that shows the science concept in operation.

Following is an example of a rubric for assessing a science project (product)

Rubric for Assessing a Creative Project

Criteria	Unacceptable	Acceptable	Target
Concept	The science concept is not at all incorporated in the project.	Incorporation of the science concept is minimal	The science concept is very well incorporated in the project
Uniqueness	Artifact produced is very common	Artifact produced is somewhat common	Artifact produced is exceptional
Resourcefulness	Does not show initiative in using resources	Manifests little initiative in using resources	Very enterprising in the use of a variety of resources
Functionality	Work does not satisfy the objective	Work satisfies the objective to a limited extent	Work clearly satisfies the objective

4. Self-Designed Experiments

Two of the three C's of science teaching are *creativity* and *critical thinking.* They should be developed in students through such activities as: • Designing experiments • Problem-solving • Project work	**3 C's of Science Teaching** **C**reativity **C**ritical thinking **C**ivic conscience

When students are assigned to design an experiment to test their hypotheses, a rubric for assessing their work should be developed and explained to them. Another rubric to be discussed with them is the rubric for carrying out the experiment they have designed. Following is a sample task and the accompanying rubrics

Task : Designing an experiment and carrying it out

I. Designing an Experiment

A. Hypothesis is correctly stated; materials are appropriate; procedure is organized; observation questions are correct.
B. Hypothesis and materials are stated; procedure has few errors; only one observation question is provided
C. Hypothesis and materials are stated; procedure has some errors; only one observation question is provided
D. Hypothesis and materials are stated; procedure is disorganized; no observation question is given

II. Carrying out the Experiment

A. Materials are complete, observation table is provided, questions are answered and conclusion is stated.
B. Materials are complete, observation table is not provided but questions are answered and conclusion is stated.
C. Materials are complete, observation table is not provided, questions are not answered but conclusion is stated.
D. Materials are not complete, observation table is not provided, questions are not answered correctly and conclusion is not properly stated.

Below is a sample activity that makes use of the above-mentioned rubrics.

This is a lesson on electromagnetism. After making an electromagnet, the students are asked to formulate hypotheses on how to make a powerful electromagnet. To test their hypotheses, the students are asked to design an experiment. Their self-designed experiment is assessed by the first part of the rubric above. The experiment they carry out can also be assessed by the second part of the rubric.

While students perform an experiment the following process skills can be assessed.

- ✓ Observing
- ✓ Classifying
- ✓ Communicating
- ✓ Predicting

- ✓ Experimenting
- ✓ Controlling variables
- ✓ Measuring
- ✓ Making conclusions

<u>Process Assessment</u>

1. Observations

Aside from using a rubric, the process skills mentioned above can also be assessed through an observation checklist. The checklist contains very specific

behaviours that are expected to be demonstrated by the students. As the students perform a science activity in groups they can be assessed individually. Each individual performance can be assessed using the observation checklist below.

Group !

Process Skills Indicators	Jo	Ben	Amy	Luz	Ann	Cris
Makes correct tables and graphs						
Makes predictions based on data/patterns						
Describes clearly						
Classifies according to attributes						
Measures accurately and uses correct measuring devices and units						
Makes detailed observations by jotting down notes						
Controls variables correctly						
Sets up equipment and materials precisely						
Carries out an organized procedure of performing an experiment						
Makes conclusions based on experiment results						

✓ If the student exhibits the behavior indicator
X If the desired behavior is not exhibited
NA If the behavior is not applicable to the activity

The following example is another observation checklist that measures the students' social skills as they work in groups. One of the objectives of group work is to develop in students the social skills needed to become productive members of society.

When the teacher's objective is the development of social skills during group work, the frequency of occurrence of a particular skill can be assessed using a rating scale. Following is an example of such rating scale.

Social skills rating scale

For each of the following social skills, check the student behavior you are observing in terms of:

1. Never
2. Seldom
3. Sometimes
4. Most of the time
5. Always

How often do the students show the social skills below?

	1	2	3	4	5
1. Staying on task with the group					
2. Speaking in quiet voices					
3. Taking turns to talk					
4. Listening attentively					
5. Contributing ideas					
6. Asking questions					
7. Interrupting appropriately					
8. Encouraging one another					
9. Resolving conflict					
10. Speaking politely					

2. Oral Presentations

Following are the science activities that need oral presentations:

- Presentation of the results of the experiment performed by the group, where each member of the group is assigned each element of the experiment report.

A Sample Task Chart for Group Reporting

Elements of the Report	Tasks	Member In-Charge
Statement of the problem and hypothesis	Explaining what the problem is all about and the tentative solution arrived at	
Materials and procedure	Describing the materials and how these materials were used in the experiment	
Observations	Answering the observation questions and other things noted during the experiment	
Conclusion	Interpreting the results from a data table or graph or a series of events that led to the conclusion	

- Presentation of research findings (by group or individually)

  Some teachers assign students to do research as a group project. An example is collecting information about the planets in the solar system not found in the textbook. Each planet is assigned to a group for presentation to the class.

- Presentation of group output

  When students are grouped to summarize the lesson and apply what they have learned to practical life situations, their output is presented to the class. To maximize the participation of all the members of the group, roles need to be assigned for the presentation.

  For example, there should be presenters for each topic. Those who are less proficient in the language of instruction can share their thoughts through drawings and charts.

In all oral presentations there should be a scale to rate performance

Rating Scale for Oral Presentation

Criteria	A	B	C	D
• Knowledge of lesson content/activity				
• Organization of ideas				
• Use of visual aids to enhance understanding				
• Accuracy of explanations				

Legend: A – Very Good
B – Good
C – Fair
D – Need Improvement

3. Role Play

Role-playing provides many opportunities for students to use kinesthetic, artistic, musical, spatial, and other modalities to demonstrate their understanding of science concepts.

Dramatization and pantomimes are common examples.

Drama:

The development of a butterfly from an egg is difficult to observe. The text simply describes what happens in each stage of development. Students can be asked to dramatize what they think happens during the process of complete metamorphosis that a butterfly undergoes. From their dramatization, the teacher can determine how well they have understood the lesson

Dance

After studying how molecules behave when heated, the teacher can ask the students to pantomime the action of the molecules of solids when heated and what happens if heat is continuously applied to the molecules. Each group of students should be able to create dance movements to show the movement of molecules when heated. These demonstrations can provide the teacher with important knowledge about the current schema of t students regarding the concepts of expansion and contraction of molecules.

Performances and exhibitions motivate students to get involved and have ownership in their own learning. Thus, science teachers should use creative performance to assess conceptual understanding.

Rubric for Assessing Creative Performance

Concept	Very clearly presented	Clearly presented	Somewhat clearly presented	Not clearly presented
Creativity	Movements utilized are extraordinary and quite appealing	Movements utilized are ordinary but quite appealing	Movements utilized are ordinary and less appealing	Movements utilized are not appealing at all
Synchronization	Very well synchronized	Well synchronized	Not well synchronized	Not synchronized at

				all

4. Interviews

Interviews involve observing and questioning students to find out more about their cognitive processes, levels of understanding, and ability to make connections and apply concepts. Interviews also reveal students' feelings and attitudes about science.

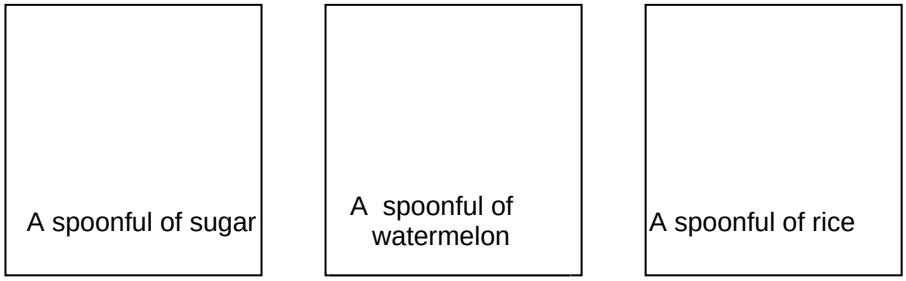
Advantages

- Interviews are effective diagnostic tools.
- As an embedded assessment, interviews provide directions in teaching.
- They encourage students to reflect upon their own thinking.
- They provide additional information about different science conceptions.

Conducting Science Interviews

- Use pictures, tools or manipulatives
- Give clear instruction for the performance of a task.

  Example: (Interviewer) Tell me which food in the picture will give you the most energy?



- Have the student explain the reason for his/her answer.
- Allow plenty of wait time so that the student can give a thoughtful response
- Refrain from teaching or asking leading questions.
- Keep a record of all the responses.
- If the student is given a problem to solve, ask the student to describe his/her thought processes while solving the problem

Another Example:

Interviewer: (Shows a drawing of a house). Change the wiring of the house so that when one bulb gets busted the rest will still light.

(Gives out materials). Use the following materials: bulbs, wires, tape, batteries, bulb sockets, scissors.

In Conclusion

Different students show what they know and can do in different ways. Therefore, assessment should not be focused on very limited sources of information, such as paper-pencil tests. The use of performance assessments allows for multiple approaches, thus giving a well-rounded picture of students' performance.