

SCIENTIFIC ABILITIES and RUBRICS TO ASSESS THEM

compiled by Jane Jackson, April 2016

Modeling Instruction and ISLE (& PUM) are super-compatible. They complement each other. ISLE is very strong on the research, while Modeling Instruction excels at dissemination. Modelers do well to study ISLE (& PUM). Here are resources on scientific abilities & rubrics to assess them.

Eugenia Etkina wrote, regarding ISLE (and PUM): "A large emphasis in formative assessment is placed on feedback. For each scientific ability, we use a specially designed and validated rubric."

1) Updated ISLE rubrics (as of July 2014) to assess scientific abilities can be downloaded at

<https://sites.google.com/site/scientificabilities/rubrics>

Also high school versions, used with PUM (one 9-page document).

What is the value of these rubrics, for students? I quote from that webpage:

Scientific ability rubrics provide students guidelines for their work. For example, when students design an experiment in a lab, the rubrics help them focus on important elements of an experiment such as drawing a picture, describing the mathematical procedure, describing assumptions made in the procedure and evaluating effects, and recording experimental uncertainties, their effects and ways to minimize them. Students also use the rubrics to self-assess their work after performing an experiment and improve it if necessary.

2) Want more motivation on why & how to use rubrics? Read some sample student work for each scientific ability, with rubric scores & reasons for scores.

Download 7 "Formative Assessment Tasks" at

<https://sites.google.com/site/scientificabilities/formative-assessment-tasks>

[Jane's note: These are outstanding resources for honors & AP/Dual Enrollment physics. The only thing missing is system schema. David Hestenes reminded a group of us (at the STEMteachersPHX unconference in January) that a crucial first step is to define the system and show diagrammatically its connections with its environment, in a system schema.

A useful resource on system schemas is by Brant Hinrichs, at

http://modeling.asu.edu/modeling/SystemSchema_3rdLaw_Hinrich.pdf]

Brant wrote that a system schema "serves as a conceptual bridge for students to more abstract representations like free-body diagrams and Newton's Laws."

3) Want to read research on scientific abilities?

The first publication on scientific abilities & rubrics is:

E. Etkina, A. Van Heuvelen, S. White-Brahmia, D. T. Brookes, M. Gentile, S. Murthy, D. Rosengrant, and A. Warren, Scientific abilities and their assessment, Phys. Rev. ST Phys. Educ. Res. 2, 020103 (2006)

Download in pdf at

<http://journals.aps.org/prper/abstract/10.1103/PhysRevSTPER.2.020103>

[Jane's note: their example is similar to an AP physics-1 free-response question.

Ref. https://secure-media.collegeboard.org/ap-student/pdf/physics-1/ap15_frq_physics_1.pdf]

Two follow-up publications on scientific abilities are:

* How long does it take? A study of student acquisition of scientific abilities.

Eugenia Etkina, Anna Karelina, and Maria Ruibal-Villasenor,

Phys. Rev. ST Phys. Educ. Res. 4, 020108 – Published 3 December 2008

<http://journals.aps.org/prper/pdf/10.1103/PhysRevSTPER.4.020108>

* Using action research to improve learning and formative assessment to conduct research.

Eugenia Etkina, Anna Karelina, Sahana Murthy, and Maria Ruibal-Villasenor.

Phys. Rev. ST Phys. Educ. Res. 5, 010109 – Published 3 June 2009

<http://journals.aps.org/prper/pdf/10.1103/PhysRevSTPER.5.010109>

These 3 articles and many more are at

<https://sites.google.com/site/scientificabilities/publications>

4) General resources to implement ISLE and PUM are at

<http://paer.rutgers.edu/resources.php>