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Implementation

Purpose of the SAAR

To help students self-assess and improve their work and to help instructors assess students' scientific abilities as evidenced in their writing around experiments and design tasks.

The scientific abilities include:

- A) The ability to represent information in multiple ways
- B) The ability to design and conduct an observational experiment
- C) The ability to design and conduct a testing experiment
- D) The ability to design and conduct an application experiment
- F) The ability to communicate scientific ideas
- G) The collect and analyze experimental data
- I) The ability to evaluate models, equations, solutions and claims

Course Level: What kinds of courses is it appropriate for?

Upper-level, Intermediate, Intro college, and High school

Content: What does it assess?

Scientific reasoning (represent information in multiple ways, design and conduct experiments, communicate scientific ideas, collect and analyze experimental data, evaluate experimental results)

Timing: How long should I give students to take it?

N/A minutes

Example Questions

| RUBRIC F: Ability to communicate scientific ideas | | | | |
|---|---|--|--|--|
| Scientific Ability | Missing | Inadequate | Needs improvement | Adequate |
| F1 Is able to communicate the details of an experimental procedure clearly and completely | Diagrams are missing and/or experimental procedure is missing or extremely vague. | Diagrams are present but unclear and/or experimental procedure is present but important details are missing. It takes a lot of effort to comprehend. | Diagrams and/or experimental procedure are present and clearly labeled but with minor omissions or vague details. The procedure takes some effort to comprehend. | Diagrams and/or experimental procedure are clear and complete. It takes no effort to comprehend. |
| F2 Is able to communicate the point of the experiment clearly and completely | No discussion of the point of the experiment is present. | The experiment and findings are discussed but vaguely. There is no reflection on the quality and importance of the findings. | The experiment and findings are communicated but the reflection on their importance and quality is not present. | The experiment and findings are discussed clearly. There is deep reflection on the quality and importance of the findings. |

Access: Where do I get the assessment?

Download the assessment from physport at www.physport.org/assessments/SAAR.

Versions and Variations: Which version of the assessment should I use?

The latest version of the SAARs, released in 2014, is Version 5.

Administering: How do I give the assessment?

The SAARs can be used in three ways: 1) A student or a group of students can use the rubric to help self-assess her or their own work, and then revise it 2) An instructor can use the rubric to evaluate students' responses and to provide feedback. 3) A researcher can use them to monitor students progress and to compare students from different courses.

In all cases, choose the rubric that assesses the scientific ability you are interested in. Use the descriptors on the scoring rubrics to

assign a rating from 0–3 to describe the student work (0, missing; 1, inadequate; 2, needs some improvement; and 3, adequate).

Scoring: How do I calculate my students' scores?

The goal of the rubrics is formative self-assessment and assessment. Therefore the students need to be able to revise their work using rubric's feedback. The developers recommend using no more than 5-6 rubrics per lab. The rubrics can be used as a summative assessment tool, but only if the students are familiar with them through formative assessment. They can also be used for research purposes.

To use the rubric in a summative fashion, and calculate a score, use the descriptors in each rubric to assign either a numerical score or a descriptive score for a portion of student writing related to a certain sub-ability. Give students a descriptive score and the rubric, as numerical scores were found to have a negative effect on student learning.

| Rubric numerical score | Rubric descriptive score |
|------------------------|--------------------------|
| 0 | Missing |
| 1 | Not adequate |
| 2 | Needs some improvement |
| 3 | Adequate |

The rubrics are used by students, teachers, designers of the lab and researchers for different purposes as described below.

Students: 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.

Teachers: Teachers and Teaching Assistants use the rubrics to provide formative assessment when students are working on a task in a lab or recitation. TAs also use the same rubrics to evaluate students' reports and to grade lab practical exams and other free-response exam questions.

Lab designers: Descriptors for individual scientific abilities serve as goals for lab designers to develop a lab write-up for students. For example, each design experiment (see section 'Formative Assessment Tasks/Design Experiments') has many parts, each of which corresponds to one or more sub-abilities in a rubric.

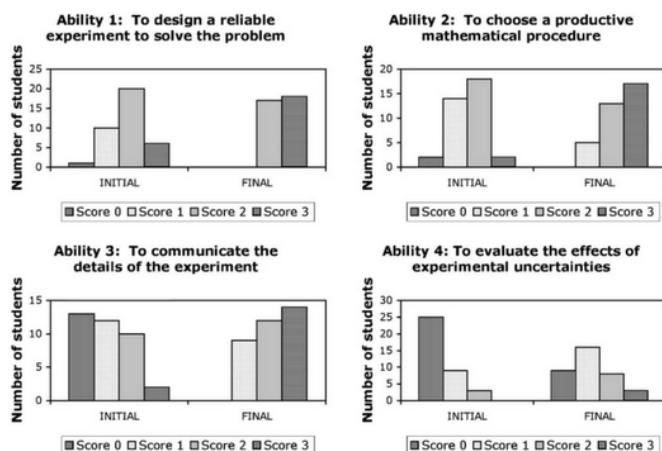
Researchers: Rubrics are used to score students' lab reports and exam questions over a long time to determine how students' scientific abilities change

Clusters: Does this assessment include clusters of questions by topic?

Since the SAARs are a set of rubrics, there are no clusters of questions.

Typical Results: What scores are usually achieved?

These SAARs have been used to look at how introductory physics classes influence students' scientific abilities. The developers tested these rubrics in their introductory physics lectures and labs and found the results shown below for a sub-set of the scientific abilities ([Etkina et al., 2006](#)).



Interpretation: How do I interpret my students' scores in light of typical results?

Look at the distribution of numerical scores for each sub-ability assessed with a particular rubric to get a sense of your students' strengths and weaknesses around scientific abilities.

You can use the rubrics to assess your students' writing (e.g., lab report or design task) at the beginning and end of your course, and look at the difference in distribution of numerical scores to get a sense of how your course is improving your students' scientific abilities (see Typical Results for an example).

Resources

Where can I learn more about this assessment?

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

Translations: Where can I find translations of this assessment in other languages?

We don't have any translations of this assessment yet.

If you know of a translation that we don't have yet, or if you would like to translate this assessment, please [contact us!](#)

Background

Similar Assessments

There are no similar assessments to the SAARs.

Research: What research has been done to create and validate the assessment?

Research Validation: Silver ●

This is the second highest level of research validation, corresponding to at least 5 of the validation categories below.

- ☒ Based on research into **relevant theory and/or data**
- ☒ Studied using **iterative use of rubric**
- ☒ Studied using **inter-rater reliability**
- ☐ Studied using **expert review**
- ☒ Research conducted **at multiple institutions**
- ☒ Research conducted **by multiple research groups**
- ☒ **Peer-reviewed publication**

Research Overview

The SAARs were developed based on “the history of the practice of physics, the taxonomy of cognitive skills, recommendations of science educators and an analysis of science-process test items.” ([Etkina et al., 2006](#)) Once the authors had the list of abilities, they broke up each ability into smaller sub-abilities that could be individually assessed with a rubric, and created a rubric for each of the seven abilities. The developers then used the rubrics to assess student work, and discussed discrepancies in scores and refined the rubrics. They repeated this process of rubric refinement until they reached an 80% agreement level on the rubric scores. The results of using the SAARs are published in one peer-reviewed publication.

Developer: Who developed this assessment?

Eugenia Etkina, Alan Van Heuvelen, Suzanne White-Brahmia, David T. Brookes, Michael Gentile, Sahana Murthy, David Rosengrant, and Aaron Warren

References

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