RITES Guidelines for Authors

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Introduction

This Guide and attached "RITES Investigation Rubric" are designed to help anyone who is creating or modifying RITES Investigations generate high-quality materials that meet RITES standards. This document addresses the content, not the technical details of authoring.

Remember the Rubric

RITES curriculum materials will be judged on eight dimensions, so developers should become familiar with these. The attached rubric provides a brief description of how to judge quality for each of these dimensions and ends with a scoring rubric that will be used throughout the project.

Use Appropriate Writing Style

A big problem for many students is that they do not read well or carefully, especially the targeted low-performing students. You can help them by limiting your vocabulary and by avoiding long, complex sentences. Introduce the least possible number of scientific terms. Use the following websites to evaluate the reading level that your writing requires. Since we are trying to reach low-performing students, aim at grade six for middle school and grade eight for high school.

http://bluecentauri.com/tools/writer/sample.php

http://www.editcentral.com/gwt1/EditCentral.html

Try to introduce a concept with common-sense ideas before giving that concept a technical word—or avoid the technical jargon completely. Define new words carefully.

Avoid anthropomorphism. Instead of saying that atoms want to disburse (ascribing a will to atoms), say that they disburse due to their random motion (giving the scientific explanation). Don't say that two atoms each pull on an electron (ascribing an action to atoms); say that electrons are like the rope in a tug-of-war (an analogy).

Use lots of illustrations and give them captions that duplicate the text. It would be ideal if non-readers could get all the main concepts from illustrations and interactives. While this ideal is seldom possible, try to address main points through visual means.

Consider Classroom Implementations

The ideal classroom will have enough computers for students to work individually or in pairs. RITES materials should be designed for this configuration—it is definitely the way of the future. Having high quality materials for this format will hasten the day that schools decide to purchase the required computers.

Unfortunately, only about 30% of RITES classrooms currently achieve this ideal. Most will have one computer in the front of the room that teachers use with an attached projector. RITES materials must, therefore, be able to be used in the one-computer classroom. In this mode, a teacher will want to focus on the interactive parts of an investigation and not even show students text. The teacher notes need to provide guidance about how to use the interactive and how to stimulate a whole-class discussion about the interactive.

The Process

There are four things you need to decide on **before** you start writing: your instructional goals, the computer-based interactive(s), an outline, and an assessment. They should all work together:

1. The instructional goals must address key parts of the standard.
2. The outline must include all the major student actions that will lead to understanding.
3. The computer-based interactives must help students understand the key concepts.
4. The assessment must measure how well the goals have been mastered.

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Be sure to ask whether the computer interactives contribute to student understanding in ways that are superior to alternative, non-computer types of activities. For instance, motion sensors are uniquely helpful in learning about position and velocity graphs; molecular simulations enable students to visualize dynamic behavior that is very difficult to convey through words and pictures alone.

Don't forget the assessment, which is how teachers will determine each student's mastery of the content. It can be a mix of questions and performances, and it must work as a printed worksheet for those classrooms without multiple computers. Be sure that the assessment matches the instructional goals.

The RITES Authoring System

A RITES **investigation** consists of a series of **activities**, which in turn contain **sections** and **pages**. A page has a series of **elements**. They cascade one after the other, creating a linear sequence in a scrolling widow. There are many kinds of elements—text, images, various tools such as data collectors, graphs and models, and various kinds of assessments such as open-response and multiple-choice questions.

Every page can have associated notes that only a teacher sees—answers, suggestions, background information. This creates a "teacher's edition" that can greatly simplify a teacher's job.

Using the Template

RITES has developed a **template** that suggests a structure of sections and pages for an investigation and several typical activities. This template is the product of a great deal of thinking about how to implement research findings and to meet Rhode Island's instructional standards.

This template should be considered as a starting point, but not as a rigid requirement. Each activity has its own logic that may require deviations from the template. Typical modifications include multiple "explore" sections, "messing around" hands-on experiences before an experiment, and supplementary materials. Do not feel bound by the template, but try to include all of its basic sections and depart from it only for good reasons.

Include Inquiry

A central theme of RITES is that students learn science best through guided inquiry. The central role of inquiry in RITES is supported by the standards and a large body of research. The national science teaching standards (AAAS (American Association for the Advancement of Science), 1993; NRC (National Research Council), 1996) are emphatic about the importance of inquiry to science learning. The AAAS Benchmarks place student inquiry front and center. The Rhode Island standards are based on AAAS Benchmarks and inherit their focus on inquiry. Similarly, the NRC standards emphasize inquiry and assert that "Science as inquiry is a basic and controlling principle in the ultimate organization of ... science education." In other words, the entire curriculum should be organized around student inquiry, providing time for it and making sure that prerequisite skills, attitudes, and knowledge are treated to support this. Fully 30% of the NECAP science assessment measures inquiry skills by requiring students to undertake an experiment, analyze data, and write their conclusions.

The important point is that powerful learning happens when students have a meaningful question and make observations that answer the question. If the question is too hard, a student can become lost and waste a lot of time, so some sort of guidance or "scaffolding" is needed to help students.

It is difficult to convert these general ideas of "guided inquiry" into practical materials, but that is the curriculum designer's goal. RITES has defined three kinds of student activities that could be part of a curriculum:

A. Observe something while following a list of steps (i.e., lab procedure)
B. Meet a challenge provided by the teacher (how it is met is the student's choice)
C. Learn what you can about a situation (open-ended, wide range of material available)

Ask: who controls the methods and the goals of the activity? If the teacher controls both methods (steps) and goals, it's type A; if the student controls methods but the teacher controls goals, it's type B; if the student controls both methods and goals, it's type C.

Each kind of inquiry has its role and pitfalls. Type A provides the greatest guidance, which may be particularly important in a "wet" lab where there are dangers and expensive reagents, but does not encourage initiative or thinking on the part of the student. Type C probably promotes the most memorable learning when successful, but has the greatest potential for wasted time and effort. Type B can be a good compromise, but shares with C the potential of wasted time and effort.

Most current science activities are Type A. Often the RITES curriculum designer's goal is to take a known activity that is traditionally done as type A and shift toward type B or C. This can be done by asking for predictions, giving more chances to "mess around" (with either a simulation or a hands-on experiment), providing more open-ended questions to explore, or asking for more thoughtful explanations.

Ideally only a small portion of a given RITES activity would be type A. For instance, students might run through a complex experiment with type-A instructions, then repeat it with more open-ended Type B or Type C goals.

Use Probes

Because RITES activities are computer based, they can integrate probes into the learning experience in a powerful way, and every RITES investigation should take advantage of this. The ability to take real-time data with sensors and save it in a graph offers many advantages over a traditional pencil-and-paper lab, especially with regard to inquiry.

A student can take and save data quickly and easily. The immediacy of data collection can be paired with frequent chances to talk about the experiment and offer explanations

Multiple runs are also easy, making it possible to repeat an experiment many times and explore alternative ideas about what's going on.

A student can be asked to make a prediction and then compare it to the results of the experiment.

The data and notes about it is automatically saved as part of the student's work.

Experiments should provide insights into meaningful scientific questions, and not just provide cookbook confirmations of principles that the student has learned by rote.

The RITES software will accommodate probes and interfaces made by Pasco, Vernier, and other vendors. At this writing, we have been having some problems accommodating older Pasco probes. For current information about which probes are supported, see http://rites.concord.org.

To our knowledge, only Vernier and Pasco probes are in use in RI. If you design an Investigation you should test it with both Pasco and Vernier probes. Similar probes may be slightly different in ways that would give problems for your experiment.

Be careful about specifying esoteric, expensive probes. Temperature, light, and motion probes are most common and can be required at any grade. RITES has funding that schools can use for probe purchases, but before specifying an unusual probe, check with the RITES central office.

One of the most compelling applications of probes is to graph a value over time and compare it to another graph. The other graph can be data generated under different conditions, a prediction, or an authored graph. The graphing tool supports multiple runs that are color-coded and can be selectively graphed and removed.

Another good strategy is to ask the student to predict the data graph using a predicting tool. RITES can be set up to permit the student to sketch a graph. Then, the sketch can be shown on the same graph with the data. A similar strategy is for the author to provide a sketch and ask the student to reproduce that graph using the probe. For instance, if the probe is a distance sensor, the author can have a graph that specifies a motion and the student has to walk back and forth to match that motion. This has proven to be a very powerful and quick way for kids to learn how to interpret a graph.

As author, take advantage of the ability of students to annotate graphs. For instance, you can ask a student to label where the sample as cooling the fastest, or where the light was turned on. These annotations provide a quick way for a teacher to judge whether students can interpret the graphs and understand the underlying science.

Use Models

Computer models or simulations offer a way for students to experiment with situations that are too small, large, slow, fast, expensive, or unsafe for actual experimentation. Three very powerful kinds of models can be included in RITES:

Molecular Workbench (http://mw.concord.org/modeler/) is an environment for creating models of atoms, molecules, photons, and their interactions. These models can simulate phase change, diffusion, black body radiation, chemical explosions, and much, much more. You can create your own models or use any of the hundreds available. There are also over one hundred tested learning activities that use MW in a database at http://workbench.concord.org/database/ Use these to get ideas for RITES activities—they cannot be imported directly. MW models can include snapshots and annotations.

Rover. One of the many functions built into MW is to display any molecule in simulated 3D and to permit students to zoom through the molecule. Zooming around enhances the feeling of three-dimensionality and allows students to find active sites. Biology teachers love this functionality. Rover can include snapshots and annotations.

NetLogo (http://ccl.northwestern.edu/netlogo/) is an easy-entry agent-based programming language for modeling complex systems of all kinds, from ecosystems to global warming. There are hundreds of models already developed, but we have found it to be a very easy language for creating new models. It is based on Logo, which was developed for use by kids, so it is really easy to program. Data can be extracted from NetLogo models and used elsewhere in a RITES project. For instance, we do not like the graphs in NetLogo, but we can move data into the standard RITES grapher. Again this is a special request, but easy for RITES central to arrange.

PhET (http://phet.colorado.edu/) is a nice collection of science simulations that we can incorporate into RITES Investigations. This requires a bit of programmer time for each simulation, so it can be done only on special request. If you want to use one, make the request to RITES central and plan for enough time for this to get through the programming queue.

Include Assessment

Many kinds of assessments can be incorporated into RITES, including true/false, multiple choice, and open response. It is a good idea to mix these up. The machine-scored types can be set up to report back to students; use this during an activity so students can judge their own understanding. Machine-scored items are also helpful to teachers who can use these results to see the progress of each student. Open-ended questions take more time to grade, but provide better information about student understanding.

For questions at the ends of activities and Investigations, we highly recommend a combination of automatic and open-ended assessment called Knowledge Integration items (Linn, 2006). These consist of two parts. The first is a multiple-choice and the second asks for an open-ended justification for the student's choice. This second part is evaluated using a four-point rubric that looks at whether a student used two or more general concepts and linked them accurately to the question at hand. After using this with over 10K students, we know that the open-ended part scored using the KI rubric, is more accurate than the multiple-choice part. For more information, see (Linn, Lee, Tinker et al., 2006) or request a copy from bob@concord.org.

The result of student interactions with the probes, graphs, and annotations can be recorded as a snapshot of a graph or model. We strongly recommend using this function because a snapshot creates a helpful way for the student to remember the experiment. The snapshot can be included in an electronic report and is very easy for teachers to evaluate.

CITATIONS

AAAS (American Association for the Advancement of Science). (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.

Linn, M. (2006). The Knowledge Integration perspective on learning and instruction. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 243-264). New York: Cambridge University Press.

Linn, M., Lee, H.-S., Tinker, R., Husic, R., & Chiu, J. (2006). Teaching and assessing knowledge integration in science. *Science, 313*, 1049-1050.

NRC (National Research Council). (1996). *National Science Education Standards*. Washington, DC: National Academy Press.