NoSLab Teacher's Guide

#4: 9 March 2008

THIS IS AN EARLY DRAFT of a guide to help you use NoSLab, a set of web-based materials for science education. There are a number of different ways to think of these materials, so that makes writing this guide a little tough. We'll begin by describing NoSLab two ways:

First, NoSLab is a simulation system in which students act as scientists opening up a new area of investigation. They develop hypotheses, perform experiments, and get their ideas supported…or crushed under the weight of empirical evidence. We hope it makes that Chapter One section on the Nature of Science and the scientific method active and fun, and gives students experiences of their own to relate to the big issues of what is science and what isn't instead of having always to read a gray box in the textbook describing some long-dead scientist (often Gregor Mendel) and his equipment (peas).

Second, NoSLab is a set of tools for recording and sharing data and ideas about data. Here the data may be real, not simulated. A lesson might focus on primarily content rather than on the nature of science. The tool in this case helps students record and share data, and communicate and organize their results. It may take the place of some lab-notebook work. It can be part of writing across the curriculum. And it can definitely help you with logistics when students collect different data and everybody needs all of it.

Since the first purpose also uses the communication tools, and because the first, nature-of-science stuff is more alien, we will begin with that. But if you are more interested in NoSLab as an organizer and data communicator, fear not: you will learn much of what you need to know in the simulations, and a later section (xxx) will fill you in on how to modify the system to get what you want.

NoSLab as a Nature-of-Science Simulator

EVEN WITHIN ITS ROLE AS a simulator, there are different ways to think of NoSLab. It can be concrete or abstract, quantitative or qualitative. On the concrete, quantitative end, it is especially powerful teamed up with a data analysis package such as Fathom.

We will begin with something more elementary but still challenging: the four-color universe. The universe here is simple and abstract: a 12-by-12 array of cells, each filled with a single color: blue, red, green, or orange. To study the universe, students perform experiments (or observations). A *large* experiment studies a 3x3 subarray of the whole universe. The result of such an experiment is the *distribution* of colors in that subarray. For example, you might learn that there are five blues, two reds, and two greens. A small experiment works the same way, but it is only 2x2.

Thus by making large-scale surveys and doing detailed overlap work, students can, in principle, figure out the underlying pattern. In practice, however, they run out of funds: experiments cost money, and money is limited.

This scarce-resource situation means that the student/scientists have to choose their experiments judiciously. And they have to figure out how to get more information. One of the best ways is to get data from other groups. And how do they share data? By writing papers in a scientific journal.

The journal quickly becomes the focus of student work in the simulation. With modest encouragement, students seem to develop and publish hypotheses naturally, and test the ones they read about. Furthermore, the entire history of the class's scientific endeavor is encapsulated in the journal so that the students—and the teacher—can look back to see what really happened.

We should describe the student's interaction with the software next, so that you have a clear picture of how this works.

Does this translate into better understanding of science? Probably not without a good debriefing by the teacher.

How Students Get Online

WE'LL BEGIN BY ASSUMING THAT every group has access to a computer that has Internet access. If you do not have Internet access, you need your own server (see xxx).

The easiest (and currently only) way to get Internet access to the simulation is to go to

http://www.bigtimescience.com.

There students log in. The easy way is to use a username and pasword that you give them. More on that in a bit.

Logging in takes the student to his or her **Start Portal**. There they select a world (you tell them the name of the world and they choose it from a list) and click the **Join** button.

This takes the student into the simulation. At this point, the student is ready to participate.

Introducing the Simulation to Students

LET'S LEAVE THE NITTY-GRITTY TECH issues for later and begin with what's more important: the pedagogy. How do you, as a teacher, run this thing?

The first thing I (Tim) need to tell you is: nobody knows. What I write here is only my own initial, tentative advice, gleaned from running this thing a few score times. It's probably not bad as advice, but it is by no means definitive. You will find out a lot more than I ever can, and if you don't try out new ideas, follow you instincts, *and tell me what happened*, we won't learn all the things I have missed.

That said, here are my ideas about how to start. There are two main principles:

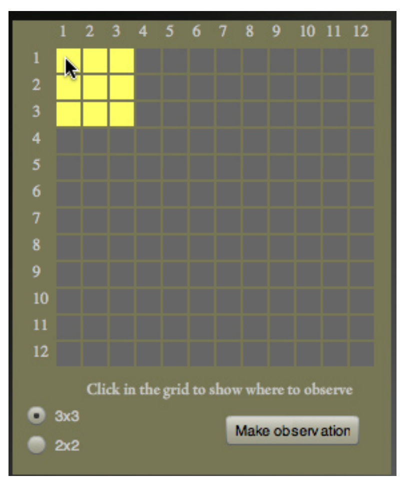
❖ Get students actually doing stuff as soon as possible.

❖ Model what could go into a journal article.

To get them started, orient them to their roles and to the scenario. For example, if you're doing the four-color universe, you might say:

"You group is going to be a scientific research group unraveling the secrets of the universe. The universe is a 12-by-12 array of squares. Each square is either blue, red, green, or orange. To find out about the squares, you do experiments. In one kind of experiment, you specify a 3-by-3 sub-array of the universe. Your results will be the *distribution* of colors in that 3-by-3 square."

That's really all they need to know to start. They will see the **Collect Data** button on the screen, so they will see where to go to do that. On that page, they will see what they have to specify in order to make an observation. They will even discover what you mean by "distribution" when they get their results. Since they're working in groups, if anyone is confused, they'll usually work it out among themselves.

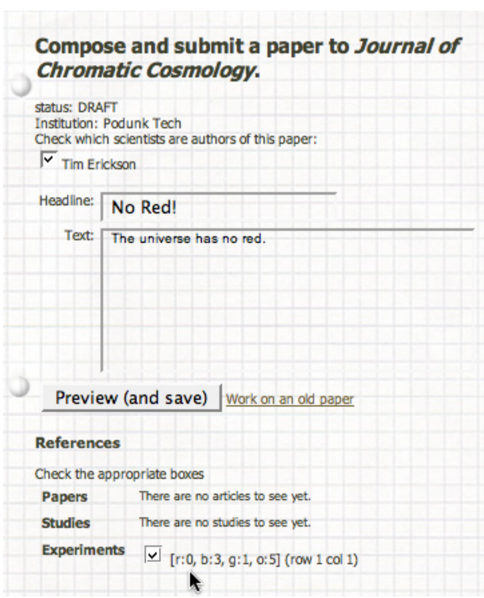


(Specifying an experiment in the 4-color universe. This is from the **Collect Data** page.)

(the results)

To get things started on the right foot, however, I often do one measurement to show them what it looks like (I will have created a team for this purpose, in which I am the only member.) Having done that, I often model writing a paper. I ask something like, "See these data? What's do you think might be true about the whole universe, *based on the data that you know so far*?" They might answer, "There's no red." I say, "Great! Let's publish!"

I go to the "office" to write a paper. I enter my name as the author, and write a brief headline and text ("No red! // The universe has no red."). And I show them how I can refer to my experimental results. I preview my paper, and then submit it to the referees.



(this looks a little different as of February 2008)

I may even show them how to review a paper, and let them see the published result. (We'll see how to review papers in a bit.)

After the Introduction

While these little demos may help students see what it going on, they take up time. Often, students can figure it all out, just as scientists do. As a teacher, your initial job will be to walk around and make sure everyone has been able to log in, then help and support them. Some students will ask what they are supposed to do. Depending on your style, you might have gone as far as creating a step-by-step handout.

Although that may be important in some circumstances, let me encourage you to leave more up to the students. This does not mean just letting them figure everything out themselves. Here are some strategies:

❖ Point out links to the help system.

❖ Point out the material written under the **Begin Investigation** link in the floor plan.

❖ Ask questions, for example:

◊ Have you read the journal?

◊ What have you been working on so far?

◊ Do these observations suggest any pattern? (You could point out, for example, when two observations are the same, but are in different parts of the universe.)

◊ You've read Smith and Wakefield. Do you think they're right? Do any of your results support their hypothesis? Do any of your results refute it? (Either way, publish!)

◊ Can you say anything about the overall composition of the universe? Does the universe change with time?

That is, help them convert their own ideas and realizations into papers. It's OK, if they just can't get started, to help them with leading questions.

By the end of most sessions, all or almost all of the teams have published a paper.

Running Out of Money

Sooner or later—often sooner—a team or two will run out of money. They get a message to ask their granting agency for more. That's you. You can decide what to do about it. Some ideas:

- ❖ Encourage students to learn what they can from the information they have. That includes data from the journal. That is, they can work and publish papers even without spending money on experiments.

- ❖ If there is enough time, let them submit proposals orally. You can do this infomally; ask them how much they want. When they give you a figure, ask them what they will use it for. They should be able to describe their plan and give a rationale, e.g.: "We need $6000 to look at the bottom middle of the universe, because nobody has looked down there." In that case, I would grant them $3000 and ask if there is any way they could do just one observation to get al the information they need.

A Symposium

It often helps at some point to stop everyone's work and hold a symposium. Ideally, a symposium is a chance for the teams to describe the direction of their research, and to let some group direction evolve from real-time conversation instead of publishing and reading the journal.

However, you may want to use a symposium to help get a class on the right track if too many groups seem to be foundering. Under the guise of a symposium, you can ask questions such as:

- ◊ What have you found out so far?
- ◊ Did the initial paper turn out to be true or not? How do we know?
- ◊ What patterns do you see?
- ◊ What are the variables?
- ◊ What are the issues that people are looking at in the journal?

You will probably be able to sense fruitful directions for groups and can use the symposium to help guide groups to them. Of course, teacher talk is not the best here, but it may be all you've got!

Debriefing

At the end of your time, everyone can step out of their scientist roles and discuss what happened. The level of the discussion will depend greatly on the experience of the students.

Younger students may only be able to reflect that they observed, that they "did experiments," and that they liked publishing.

More experienced students can get involved in deep discussions. Can you ever prove a conjecture? Can you disprove it? Were any conjectures refuted in our simulation? How does our experience correspond to what you hear about in the news?

Some Cognitive stuff

Most students (and teachers) have not dealt with the nature of science, so ideas come up here that may never have come up for you before. This is especially true of less-experienced students.

One is the difference between a report of data and a conjecture that goes beyond the data. Both are useful, but a conjecture that goes beyond the data—a generalization—can be a genuine scientific hypothesis.

Why? Because it can be *disproved*. If I write a paper saying the upper left corner is mostly green, and I have the data, there's nothing more to say. It's just data. But if I generalize and say, the universe is mostly green, that's a real hypothesis. It's *falsifiable*. It would be possible to get data that disprove our statement.

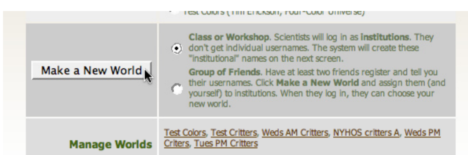
Another is the difference between an issue or a variable and the categories that it involves.

For example, in the 4-color universe, students may talk about how much *blue* there is instead of talking about the issue of *color*. In the Critters universe they may talk about the properties of males instead of talking about sex differences. Sometimes this makes perfect sense, but at other times it's clear that students don't actually distinguish between the categories (male and female) and the variable or issue (sex). And failure to do so may keep them from finding better conjectures and generalizing.

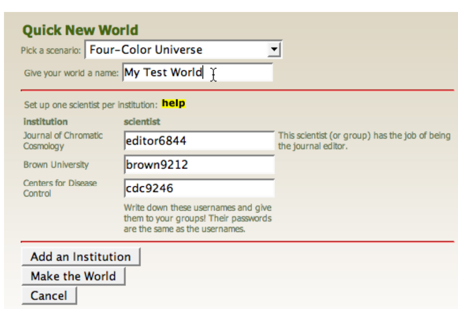
What You Need to Do to Set Things Up

ANYONE CAN GET A USERNAME and password by registering. And anyone can create a new world.

You create a new world form the **Start Portal**. Select the **Class or Workshop** option and click **Make a New World**.



This will take you to the **Quick New World** page where you will specify the name of the world, the *scenario* your world will use, and the **institutions** that correspond to the teams.



Here, I'm creating a 4-color universe that I am calling **My Test World**. It comes with three teams (institutions) already set up, in this case, the journal, Brown University, and the Centers for Disease Control.

Furthermore, you can see that the system has generated usernames that correspond to the three teams: **editor6844**, **brown9212**, and **cdc9246**.

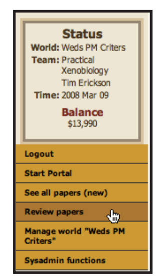
Write down these usernames! We write them on cards, so that we can hand them to students. For now, *their passwords will be the same as their usernames*.

To make more teams, click the **Add an Institution** button. There is a lmit of about 10 teams per world. We're trying to figure out what the limit should be.

If you intend to be the editor, you can delete **editor6844** and replace it with your username. Or you can use **Manage World** (described shortly) and add yourself to the editing "team."

When you are satisfied, click **Make the World**. The system creates the world and the teams, and sets up the simulation.

Reviewing Papers



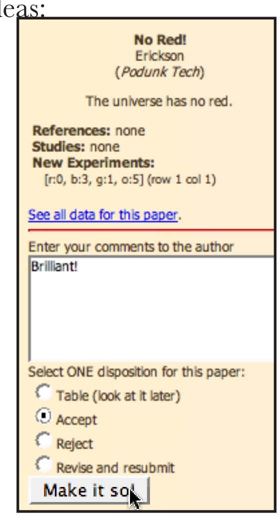
AS STUDENTS SUBMIT PAPERS, YOU (or whoever in in the "editor" team) will have to review them. You can accept them for publication, reject them outright, send back for resubmission, or "table" them, that is, leave them to be handled later.

You get to the reviewing papers module by clicking on a link in the left panel (shown).

This will take you to a page where you see a list of papers to be reviewed, numbered chronological by submit time. Choose one.

You'll then be able to change its status (accepted, rejected, etc.) and send a comment back to the author.

You will need to decide what your criteria are. Since you can send comments, you don't have to inform the students, though doing so may save you time. Here are some ideas:



❖ A paper that makes a statement that should be supported by data had better reference either the data or another paper that references the data. (There is a link that will show you all the data referred to by a paper, recursively.)

❖ If you build on somebody else's paper, reference them.

❖ Papers are for conjectures about the universe, not simply reporting data. Always draw *some* conclusion (This can be difficult, especially in some scenarios; feel free to relax this one!)

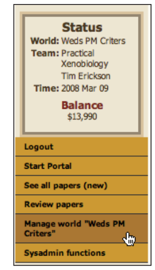
❖ If you draw the same conclusion as an already-published paper, you got beat. Sorry.

I am lenient when students are just getting started, to give them success experiences.

Later on—perhaps not much later—you might review some papers with the whole class and talk briefly about how you're going to be cracking down and making it harder to publish.

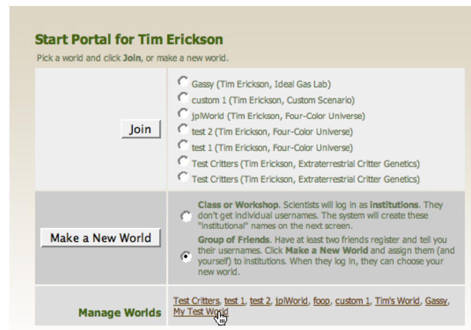
Big Important Note: The editor team has no budget. They greatly impact the direction of science, but do none themselves. You can change that (and you may want to so you can demo an experiment as editor) using World Management.

Managing a World

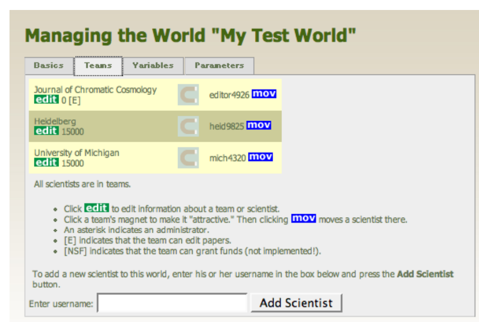


If you created a world, you have the privilege to manage it. Once you're logged in and have joined a world, if you are its creator, a manage world link appears in the left panel (shown).

The other way to get to the world manager is to click on a world's name in the lower **Manage Worlds** panel of the Start Portal:



Either scheme takes you to the world manager, which has (at least) four tabs. The next illustration shows the most vital, the **Teams** tab:



❖ Click a team's **edit** button to change its name or balance. (Ah! That's how to get more money!)

❖ Use the magnets and the **mov** buttons to adjust who is in what team.

❖ If necessary, add a scientist (such as yourself, if you forgot!) by typing in the username and clicking **Add Scientist**.

You Should Practice, But Where?

BEFORE YOU RUN ONE OF these in your own class, you should try out the features so you know how they work, *especially* in these early stages when the commands are so klugey.

To that end, just make a world, write down the usernames, and then log in as one of those users to try it.

The Premium Version

IN OUR CURRENT THINKING, THERE will be a "free" version that everybody can use, and then there wil be a "premium" version. That you pay for. We'd like feedback on this idea.

The free version will be a lot like what's described here, although some of the world management features may be disabled.

The premium version would have various perks, such as:

- ❖ Persistent worlds. Free worlds might disappear after a few days.
- ❖ Ability to control world parameters such as the specific color pattern in a universe or the genetic structure of the Critters.
- ❖ Teacher help, such as reports summarizing what teams did what.
- ❖ Access to more scenarios. (*Critters* and the *4-color Universe* wil remain free for sure.)
- ❖ The ability to bulk-load students.

Until February 2008, we had more elaborate schemes to create worlds and manage things. We found that mostly people wanted to do much simpler tasks and did not want the choices. Many of those will migrate to the premium version as it evolves. For the time being, the premium version is free.

Other Stuff, Questions, and Changes

THESE INSTRUCTIONS HAD YOU CREATE the world using the **Class or Workshop** option. The other one is **Group of Friends**. In that scheme, you know everybody's username and you put one username in each team (institution). You don't use system-generated usernames such as **yale4583**.

If you were a teacher using this a lot, and wanted to keep track of individual students, you might want to do this.

Also, if you used this before, you may remember that when you wrote a paper, you checked the names of the authors. No more. Now you type in whatever list of authors you want.

We made this change partly because different groups of students use first or last names. But more than that, we realized that in this system, everything is done by the team. The only reason we needed to know the names of the individuals was to put their names by those boxes—and that was no guarantee about who was doing the work.

Now students can call themselves what they want, and if there's mischief in naming, the editor doesn't have to publish.

Under the Hood

FROM THE OUTSIDE, NOSLAB LOOKS like a cross between a web site and a regular program. It is, in fact, delivered over the web, whether worldwide or just in your classroom. It's powered by two commonly-used open-source technologies, *php* and *MySQL*. Php (which originally stood for *personal home page*) is a language that lets you write web pages that change depending on the context. MySQL is a database engine that interacts happily with php. In addition, some of the screen widgets are written in Flash.

Php is really in the middle of all this. It gets the students' commands, looks up the answers on the database using MySQL, saves the results of experiments and the journal articles (again using MySQL), and generates the HTML that makes up the web pages. Both php and MySQL run on the server that sends out the web pages themselves. This means that the student computers *only need a web browser* (such as Safari, Firefox, or, if you must, Internet Explorer) to be able to use the system. You will also need a Flash plug-in for your browser, which is common these days.

It also means that, if you're a little bit ambitious in the computing department, or if you have a pet geek that will do your bidding, you could set up a server yourself, install php and MySQL, and run an NoSLab of your very own.

Security

This system is terribly insecure at this point. We will put in the effort later; for now it's too early.

I explain to students that this software is under development and therefore it's really easy to cheat and mess up other people's work. I say something like, "You can join someone else's team and spend their money. You can put insults in a paper, make somebody else the author, review it yourself, and get it published. It's obnoxious and really easy. So don't do it." That seems to work.

Your Own Server

This section will eventually contain information on how to set up your own server. For now that's far too complicated to contemplate.