Teaching Computer Skills Through Scaffolding

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Introduction

- Examples shown today will mainly draw on my own experience teaching:
  - Excel within a *Surface Waters* course using hydrologic data, and
  - ArcGIS in an *Introduction to GIS* course
- The same ideas apply to teaching any computer skills, however
  - We will brainstorm and discuss other possibilities toward the end of the session

Some Advice

- Software packages are not an end unto themselves:
  - They are simply tools that can open doors to new questions, methods, and solutions to interesting problems.
  - But they can be VERY complex and time-consuming to learn how to use.
- The methods required to answer a research question thus can become more problematic for a student than the question itself.
- Show them why the gain is worth the pain! And be explicit:
  - Discuss how scientists use these tools in their everyday work
  - Emphasize the value of these skills in building students' resumes

Your Attitude Counts

- As with teaching quantitative skills, be sensitive about students fears and phobias.
  - Some students find computers very intimidating; others are just easily frustrated
  - Most students learn better with positive reinforcement rather than negative
    - "That's a great question!" NOT "You haven't figured that out yet??"
- Make your classroom and office a "safe place" where it is okay to ask for help

Patience is a Virtue

- Even if you have answered a particular question a thousand times, chances are it's the *first* time for the student who just asked it.
  - Put on your "helpful face" and try to keep your frustrations to yourself

"No, that's 'Gilligan's Island.' You want to withdraw cash. Hit cancel and try again."

What if my students have a wide range of computer skill levels?

- Relax!
- If you are introducing the software for the first time, teach to the novice.
- Don't worry if your more advanced students are a little bored at first.
  - Their reward is having an easier time with the homework exercises—few will complain about that!
- Encourage the more skilled students to help teach those who need assistance.
  - *Caution:* Develop a strict definition of "cheating" on computer exercises, share it with students, and enforce it

Grading

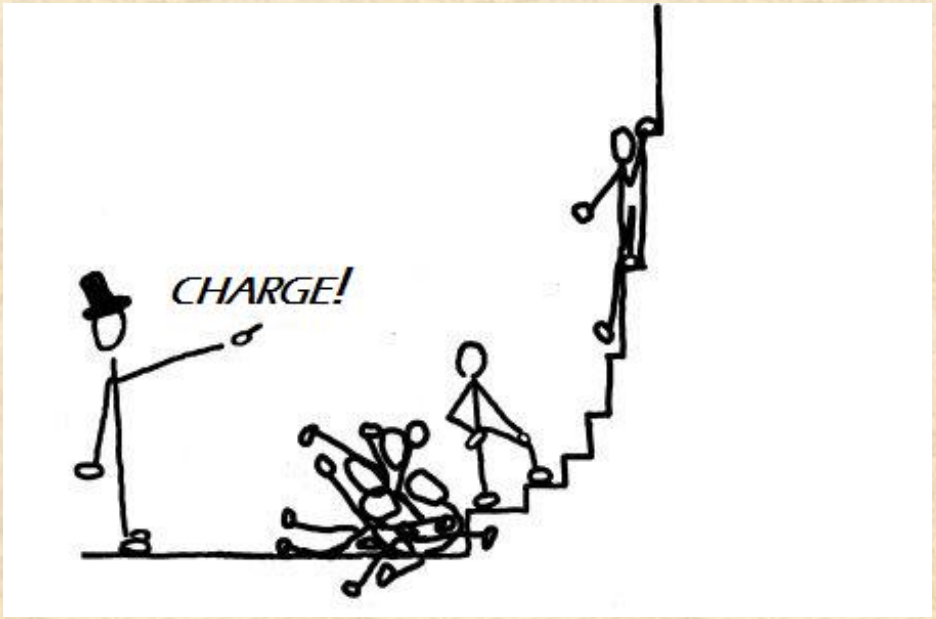
- Whenever possible, as with Excel exercises, have students email you their actual files as well as whatever printouts you want
  - If students are having problems, you can use their files to see where they are going wrong and give very specific advice and assistance
  - This also enables you to catch "technique avoidance" moves, like when a student uses a calculator to calculate a value then types it into Excel instead of writing a formula (bad! bad!)
- If a student is seriously floundering early on, consider giving him/her a chance to redo the exercise with just a late penalty
  - If you are trying to build skills through the course, a student who lacks the foundation will never be able to progress properly

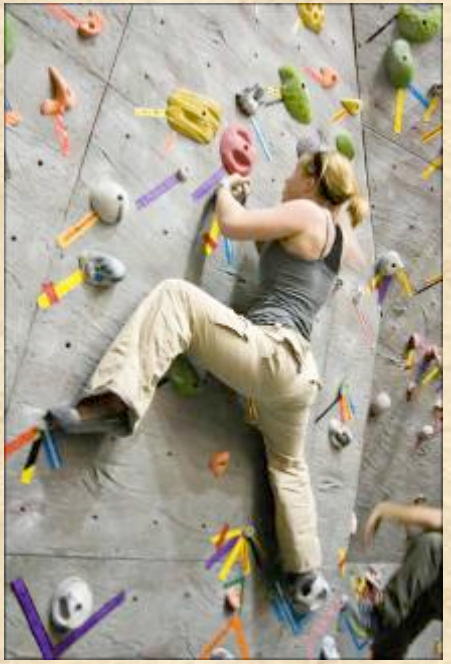
How can you best teach students computer skills?

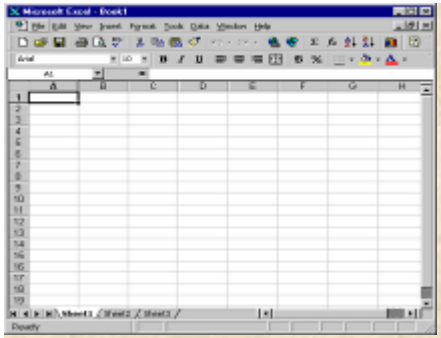
- Provide *repeated* hands-on experience plus useful background information as needed
- Use *scaffolding* to ramp up to more complex problems over the course of a term

What is meant by "scaffolding"?

- ***Scaffolding*** means providing students the opportunity to build their knowledge and skills progressively over time so that they can attain a high level of proficiency
  - Think of it as a way of constructing mental steps and handholds that enable students to climb up the learning curve
  - This approach is less stressful for students and much more effective than the "sink-or-swim" approach

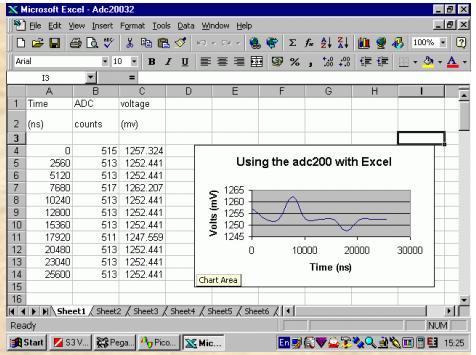






Excel Examples

from a *Surface Waters* Course



1. Warm-up exercise including tutorial-like instructions to introduce data entry, functions, formulas, copying and pasting, etc., in a provided spreadsheet using hydrologic data.

   The professor goes over this exercise in class before it is due, using an LCD projector to demonstrate tips and best practices on his/her computer

2. Exercise on calculating stream cross-section discharge from field data in a provided spreadsheet. Some instructions given.

3. Exercise on calculating flood recurrence intervals for rivers. Students download a dataset of their choice from the web and create their own spreadsheet.

Linking Computer Skills to Inquiry-Based Learning

- What is **inquiry**?
  - "an active learning process in which students answer research questions through data analysis" (Bell et al., 2005)
  - It emphasizes questioning, data analysis, and critical thinking

Bell, Randy L., Smetana, Lara, and Binns, Ian (2005) Simplifying inquiry instruction. *The Science Teacher*, October issue, p. 30-35.

What does inquiry have to do with computers?

- Computers obviously cannot do the questioning and critical thinking for students, BUT…
- Software often provides an important tool for data collection and analysis
- Learning to use the software can be built into inquiry-based exercises and projects

Building Scaffolds

- Understanding the different levels of inquiry provides you with a framework for scaffolding computer-based exercises
  - You can also be developing students' critical thinking skills at the same time

Levels of Inquiry

1. **confirmation** – Students confirm a principle or concept through an activity in which the results are known in advance.
2. **structured inquiry** – Students investigate a teacher-presented question through a prescribed procedure.
3. **guided inquiry** – Students investigate a teacher-presented question using student-designed/selected procedures.
4. **open inquiry** – Students investigate topic-related questions that are student-formulated through student-designed/selected procedures.

From Bell et al., 2005

Levels of Inquiry

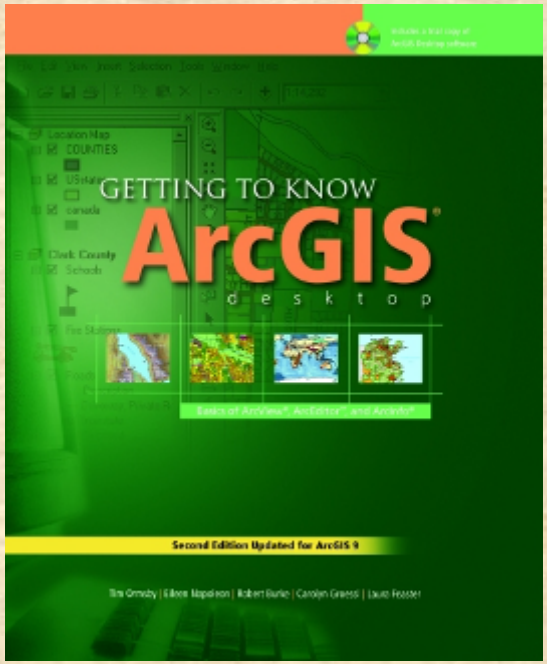
What the teacher provides the student:

Level of Inquiry	Question	Methods	Solution	Type of Inquiry
1	X	X	X	(not!) Confirmation
2	X	X		Structured
3	X			Guided
4				Open

Table adapted from Bell et al., 2005

What level of inquiry is it?

- Students work through a number of tutorial chapters in a textbook published by ESRI (the maker of ArcGIS software) called *Getting to Know ArcGIS Desktop*.
  - The instructions are very detailed
  - Images are used to show students what their screens should look like at each step

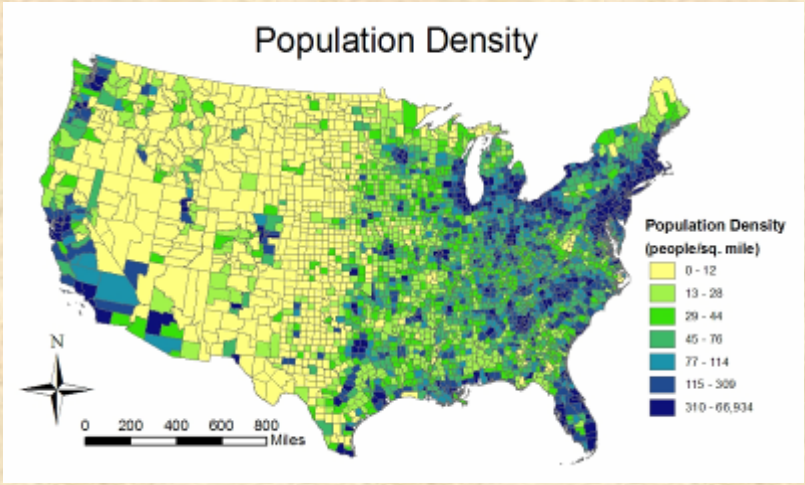


Confirmation, Structured, Guided, or Open?

What level of inquiry is it?

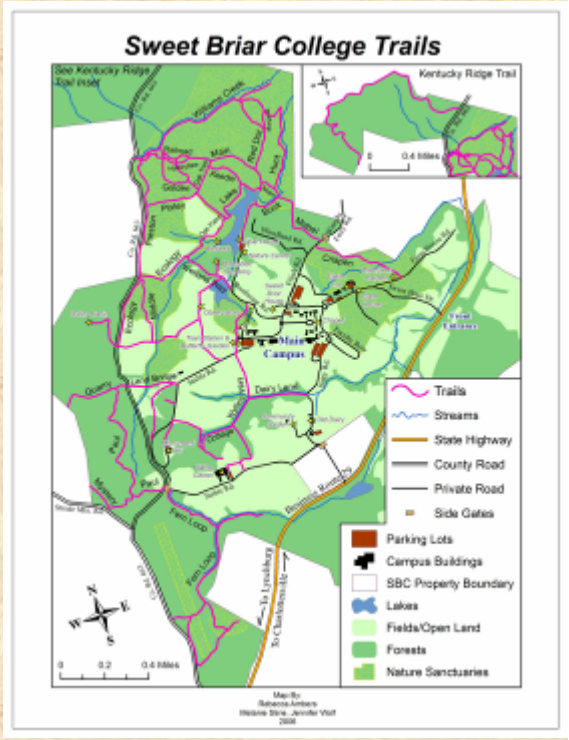
- Students complete a GIS project using data accessible from the National Atlas website to answer a question of their own design.
  - The instructions specify a minimum number of datasets that must be utilized in the project, and at least one table or graph must be included in one of the final layouts.
  - The design of the layouts is up to the student

Confirmation, Structured, Guided, or Open?



What level of inquiry is it?

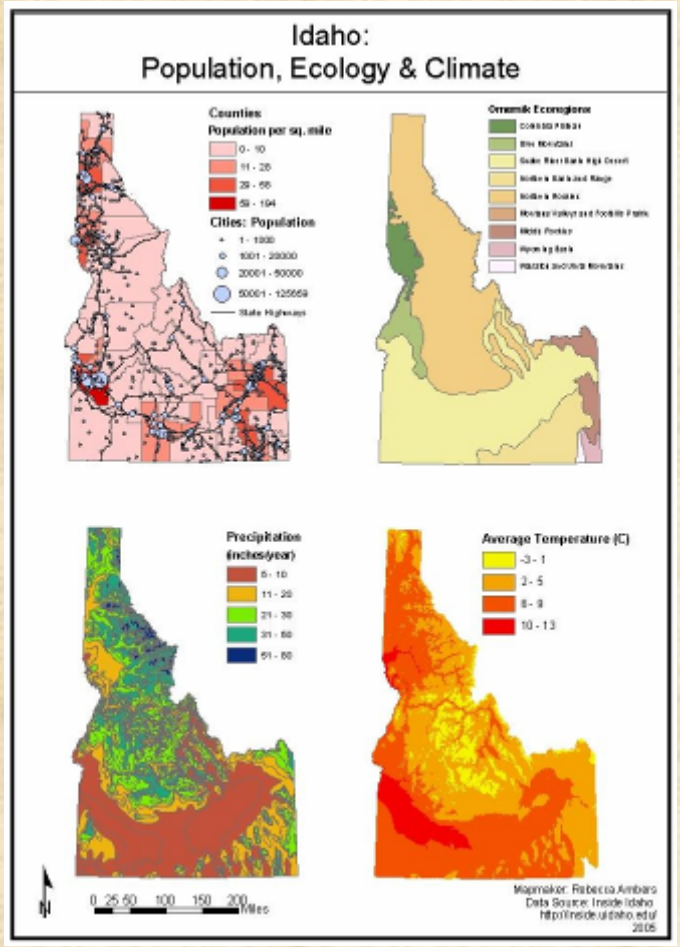
- Students complete a GIS project to design a useful, aesthetically pleasing trail map displaying the college's 20-mile trail system.
  - A few data files are provided or downloadable from the web, such as the trail layer and aerial photos.
  - All other data that the student wishes to display on her map (such as roads, land cover, buildings, etc.) she must create for herself by digitizing the orthophotos and/or topo maps.
  - The layout, color scheme, and symbology of the final map is up to the student.



Confirmation, Structured, Guided, or Open?

What level of inquiry is it?

- Students complete a project using GIS data they download from the Idaho GIS data clearinghouse website.
  - The project instructions specify which datasets to download and how each dataset should be classified and symbolized
  - The design of the final map is up to the students with the goal being an aesthetically pleasing, readable layout.



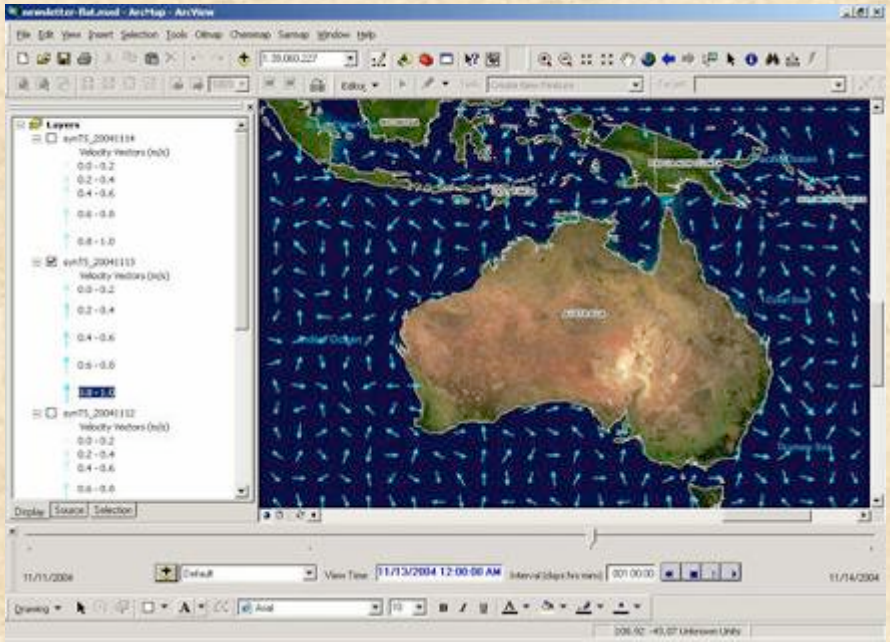
Confirmation, Structured, Guided, or Open?

How are these projects put together in the course?

- As you would expect, they are ramped up:

  tutorials → structured inquiry → guided inquiry → open inquiry

- Even with this progression, students still struggle at each step to move up to the next higher level



But they do get there!

In contrast, the first time I taught this course, I just used one big open-inquiry project, and it was a disaster.

Questions

- *What computer skills or software are you interested in teaching?*
- *Why is it important to teach students these computer skills? What goal(s) do you have for your students?*
- *Will these skills be integrated into courses on other topics, or are they the focus of a course?*

How can you incorporate scaffolding into your classes?