

# **Teaching Computation in the Sciences Using MATLAB<sup>®</sup>**

**Workshop: Carleton College • Northfield, MN**

**October 20-22 2019**

What works, how to implement it, and how to improve it

Don Baker: 30 years of teaching geochemistry, ~ 20 years of using computational methods in my courses

I have no formal education in teaching except for listening to lectures on teaching and workshops at McGill, a little bit of reading the education literature, and a MATLAB workshop.

On to course design and delivery . . .

(This presentation is my personal "view from the trenches", based primarily upon my teaching philosophy and reflections)

# Backward or Student-Centered Course Design

Identify outcomes: what knowledge and skills should the students have at the end of the course

Determine how you will assess the knowledge gained by the students

Design activities that help them succeed

# Start with the end: What are the learning goals?

(Backward design, Student-centered learning)

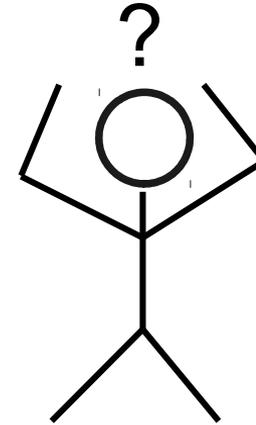
Although education research can be contradictory, the conclusion of the studies I know all agree that the first, and most important, step is to set the learning goals of the course.

These goals (as we will see) will be different for different courses, even if they all teach MATLAB.

(Our goal as teachers is to make our students better than us.)

Learning outcomes

“If you don’t know where you are going, how will you get there?”



# Knowledge content

Once the goals are defined, then the content of the course needs to be chosen to meet those goals. One of my recurring dilemmas is:



One way to approach the question is to clearly define:

1. What do you want the students to know at the end of the course?
2. What do you want the students to retain after 1 year?
3. What do you want the students to retain after 20 years?

# The necessity of assessment

“Assessment is a critical tool for advancing and monitoring students’ learning in school. When grounded in well-defined models of learning, assessment information can be used to identify and subsequently narrow the gap between current and desired levels of students’ learning and performance.”

How People Learn II: Learners, Contexts, and Cultures

<https://www.nap.edu/catalog/24783/how-people-learn-ii-learners-contexts-and-cultures>

(Try to make an assessment after each class meeting)

# Assessment: A critical component of course design and improvement

We must find a way to assess the effectiveness of the course in achieving the learning goals defined at the start of course design.

1. Student knowledge gain: Assignments, tests, projects, etc.
2. Teaching effectiveness: Student reviews, peer reviews, etc.
3. Course design: Peer reviews, comparison with other courses, etc.

(I hate assessment, whether it is assessing students' performance, my teaching or my course design, but we must do all three to succeed.)

# Nuts and Bolts 1: Course design

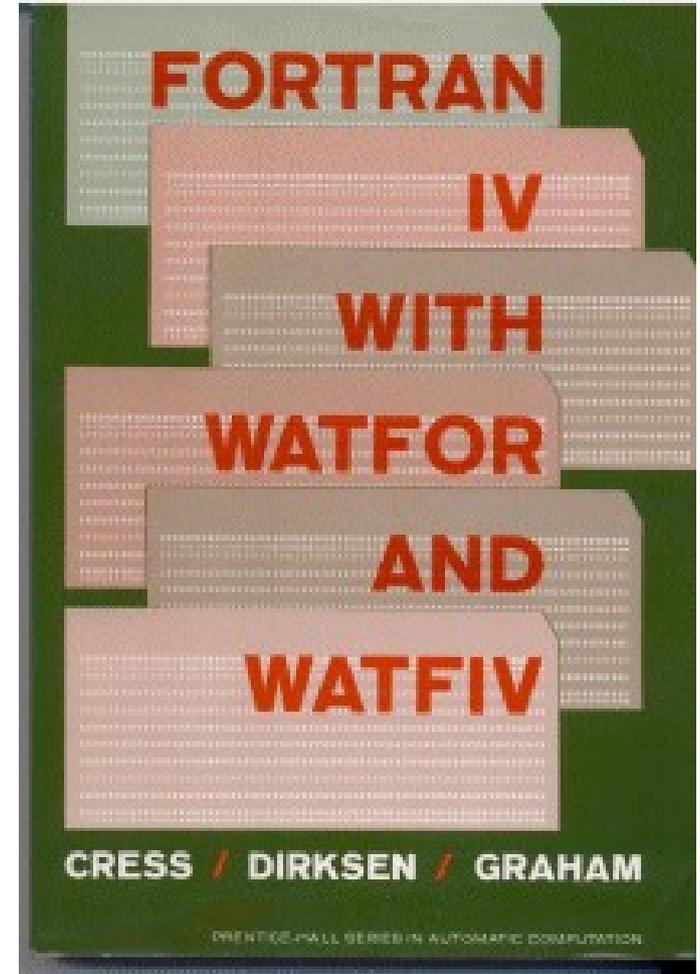
Traditional Design:

Lecture on Chapter 1  
Lecture on Chapter 2  
Lecture on Chapter 3

...  
...

Graded on exams

In some cases, the traditional method works well, but in other cases other techniques work better. However, that depends upon the subject matter, the students, and the instructor.



# Nuts and Bolts 2: Course design

Non-traditional design:

Flipped classroom

Small group research and reporting

Active learning

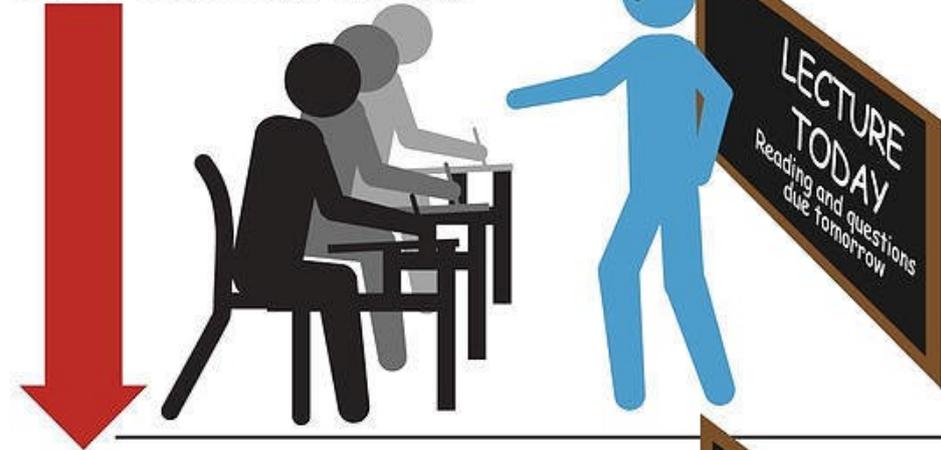
And many more . . .

Student assessment often based upon assignments, projects and open-book exams

## The Flipped Classroom

### THE TRADITIONAL CLASSROOM

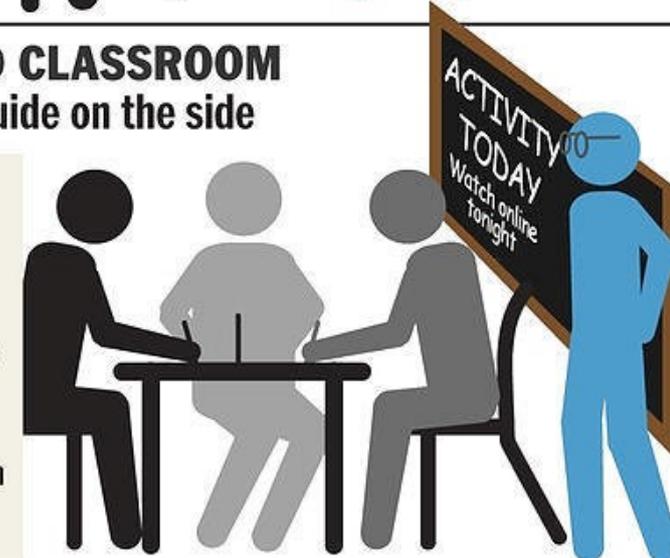
Teacher's role: Sage on stage



### THE FLIPPED CLASSROOM

Teacher's role: guide on the side

- Students watch lectures at home at their own pace, communicating with peers and teachers via online discussions
- Concept engagement takes place in the classroom with the help of the instructor



# Engagement – a critical component of teaching and learning

**Everyone Likes Something:** One way to encourage engagement is to make learning relevant

**Communicate and Care:** Strive to have personal conversations with your students

**Catch Them With Hooks:** Sometimes it's all about how you start a lesson. Just like a good speaker will begin with a compelling introduction to draw in their audience, so too might the effective teacher boost interest with the right "Hook" for their lesson.

**Include Reflection:** Before, during, or after a given lesson, it's important to give students an opportunity to process their new information.

**Give Them a Reason to Talk:** Too often, classrooms are stigmatized as places that forbid talking or interaction, but it is entirely appropriate for students to interact with one another when opportunity allows.

**Infuse Your Own Passion and Enthusiasm:** Don't forget that expressing your own passion can be a form of engagement all its own



Mr. Gilford had a knack for making high school physics fun.

# You are never teaching in a vacuum

Students arrive at the course with prior knowledge and preconceptions. Ideally you want to know what they are, which can help you put your teaching into context.

Students are often multicultural and culture has been demonstrated to affect how students learn. Awareness of this issue is important and adjusting the course for differing cultures is challenging.

In many (most ?) cases courses are part of a program and either build upon previous courses or provide the pre-requisites for future courses. These constraints must be incorporated into the course design.

(I am certain there are many more, but these are my top ones.)

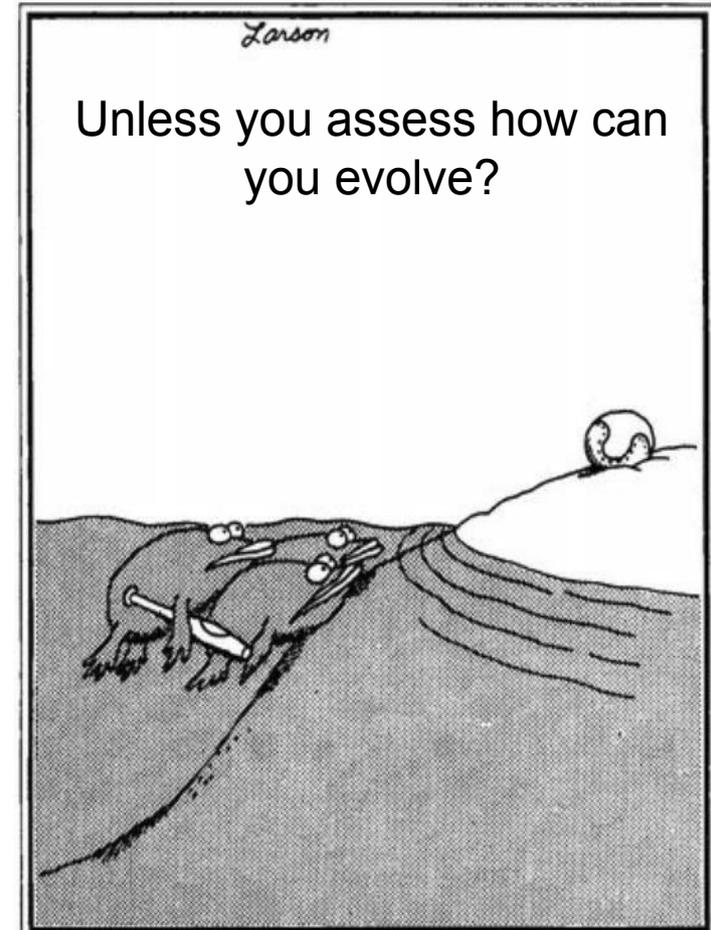
# Continuing course evolution: development never stops

Assessment provides the information;  
what we do with that information is up to  
us.

Often the information leads to new  
challenges in how and what we teach.

So we try something new and assess the  
“fitness” of the change and if it survives.

Surviving strategies should be kept, but  
course evolution must continue . . .



Great moments in evolution

# For More Information

Check the web – SERC!, and many, many more sites with suggestions

[www.nap.edu](http://www.nap.edu) – National Academies Press, try searching with the term “college teaching” and you will find many books with research and suggested best practices

University learning services – Most universities now have divisions within them that specialize in helping professors improve their teaching. They are a valuable resource that is often underused – which means they are available to help you.

Your colleagues – Find a “master teacher” and learn from them. Mentorship is a powerful teaching method