Learning How to Learn: Powerful Mental Tools to Help You Master Tough Subjects

Barbara Oakley, PhD, PE
Professor of Engineering, Oakland University, Rochester, Michigan
Ramón y Cajal Distinguished Scholar of Global Digital Learning,
McMaster University
Barb Oakley, Professor of Engineering
Oakland University
Rochester, Michigan

Terrence Sejnowski
Francis Crick Professor
The Salk Institute
Professor of Biological Sciences
University of California, San Diego
Barb Oakley, 
Professor of Engineering 
Oakland University 
Rochester, Michigan

Terrence Sejnowski 
Francis Crick Professor 
The Salk Institute 
Professor of Biological Sciences 
University of California, San Diego
Workshop with Barbara Oakley

Date: Thursday, May 7, 2015, 10:00am to 11:00am

LESSONS FROM A BASEMENT STUDIO—

HOW TO MAKE A RIVETING ONLINE CLASS

This talk describes the key elements behind the making of high quality educational videos for online learning, including scripting, filming, and editing.
Online is *highly* competitive

People *love* it.
Most universities have not yet decoded MOOCs
Death by bullets

early HIV testing in the military

- first screen with ELISA
- if positive, two more rounds of ELISA
- if either positive, two Western blot assays
- only if both positive, determine HIV infection
The cell wall of plant cells are composed from fibers of alpha glucose known as cellulose.
“Bookcase background syndrome”
“Caged” versus “Free Range” learners

18 to 24-year-olds

18 to 85-year-olds
How did you do it?
<table>
<thead>
<tr>
<th>Function $f(x)$</th>
<th>Derivative $f'(x)$</th>
<th>Integral $\int f(x) , dx$ (constant term is omitted)</th>
<th>Multiplicative derivative $f^*(x)$</th>
<th>Multiplicative integral $\int f(x)^* , dx$ (constant factor is omitted)</th>
<th>Discrete derivative (difference) $\Delta f(x)$ (constant term is omitted)</th>
<th>Discrete integral (antidifference) $\Delta^{-1} f(x)$ (multiplicative difference)</th>
<th>Discrete multiplicative integral $^\frac{1}{x} \prod f(x)$ (indeterminate product)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a$</td>
<td>0</td>
<td>$ax$</td>
<td>1</td>
<td>$a^x$</td>
<td>0</td>
<td>$ax$</td>
<td>1</td>
</tr>
<tr>
<td>$x$</td>
<td>1</td>
<td>$\frac{x^2}{2}$</td>
<td>$\sqrt{e}$</td>
<td>$\frac{x^2}{e^x}$</td>
<td>1</td>
<td>$\frac{x^2}{2} - \frac{x}{2}$</td>
<td>$1 + \frac{1}{x}$</td>
</tr>
<tr>
<td>$ax + b$</td>
<td>$a$</td>
<td>$\frac{ax^2 + 2bx}{2}$</td>
<td>$\exp\left(\frac{a}{ax + b}\right)$</td>
<td>$(b + ax)^{\frac{1}{2} + x}$</td>
<td>$a$</td>
<td>$\frac{ax^2 + 2bx - ax}{2}$</td>
<td>$1 + \frac{a}{ax + b}$</td>
</tr>
<tr>
<td>$\frac{1}{x}$</td>
<td>$-\frac{1}{x^2}$</td>
<td>$\ln</td>
<td>x</td>
<td>$</td>
<td>$\frac{1}{\sqrt{e}}$</td>
<td>$\frac{e^x}{x^x}$</td>
<td>$-\frac{1}{x + x^2}$</td>
</tr>
<tr>
<td>$x^a$</td>
<td>$ax^{a-1}$</td>
<td>$\frac{x^{a+1}}{a + 1}$</td>
<td>$e^{\frac{a}{x}}$</td>
<td>$e^{-ax} x^a$</td>
<td>$(x + 1)^a - x^a$</td>
<td>$\frac{B_{a+1}(x)}{a + 1}$, $a \notin \mathbb{Z}^-$</td>
<td>$\frac{\alpha}{\Gamma(-a)}(\psi(-a-1)(x))$, $a \in \mathbb{Z}^-$</td>
</tr>
<tr>
<td>$e^x$</td>
<td>$e^x$</td>
<td>$\frac{a^2}{2}$</td>
<td>$a$</td>
<td>$a^x$</td>
<td>$\frac{(a - 1)a^x}{a - 1}$</td>
<td>$\frac{a^x}{a - 1}$</td>
<td>$a$</td>
</tr>
<tr>
<td>$\sqrt{a}$</td>
<td>$-\frac{2}{\sqrt{a}} \ln a$</td>
<td>$x \sqrt{a} - \text{Ei}\left(\frac{\ln a}{x}\right) \ln a$</td>
<td>$a^\frac{1}{x^2}$</td>
<td>$a^{\ln x}$</td>
<td>$a^{\frac{1}{x^2} - a^\frac{1}{x^2}}$</td>
<td>$?$</td>
<td>$a^{-\frac{1}{x+a^2}}$</td>
</tr>
<tr>
<td>$\log_a x$</td>
<td>$\frac{1}{x \ln a}$</td>
<td>$\log_a x^x - \frac{x}{\ln a}$</td>
<td>$\exp\left(\frac{1}{x \ln x}\right)$</td>
<td>$\frac{(\log_a x)^x}{e^{\ln x}}$</td>
<td>$\log_a \left(\frac{1}{x - 1}\right)$</td>
<td>$\log_a \Gamma(x)$</td>
<td>$\log_a(x + 1)$</td>
</tr>
<tr>
<td>$x^x$</td>
<td>$x^x(1 + \ln x)$</td>
<td>$\exp x$</td>
<td>$e^{\frac{-1}{x^2}(1 - 2 \ln x)}$</td>
<td>$(x + 1)^{x+1} - x^x$</td>
<td>$? \frac{(x + 1)^{x+1} - x^x}{x^x}$</td>
<td>$\Gamma(x)$</td>
<td>$? \frac{1}{K(x)}$</td>
</tr>
<tr>
<td>$\Gamma(x)$</td>
<td>$\Gamma(x) \psi(x)$</td>
<td>$\psi(x)$</td>
<td>$e^{\psi(x)}$</td>
<td>$e^{\psi(-2)(x)}$</td>
<td>$(x - 1) \Gamma(x)$</td>
<td>$(-1)^{x+1} \Gamma(x)(\psi(-x))$</td>
<td>$x$</td>
</tr>
</tbody>
</table>
Short-term (working) memory

Long-term memory
Focused mode

Diffuse mode
Focused mode
Procrastinate
Procrastination – A Habit

Feel happy (temporarily)

You funnel attention onto a more pleasant task

Unhappy feeling
• Do NOT focus on finishing a task

• Turn off all distractions
• Set timer for 25 minutes
• Focus
• Reward!
Neurons send signals
Of course, it’s more complicated!
Neurons create sets of links when you learn something.

A “chunk”
Connections strengthen with practice.
“Chunks” are like sets of links in a chain.
Or like mouse paths that get bigger with practice.
Active learning (with sleep!)
Before learning and before sleep

Images courtesy Guang Yang, NYU Langone
Before learning and before sleep

After learning and after sleep

2 μm
<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
</tr>
</tbody>
</table>

![Wall](image8.png)

![Wall](image9.png)
Before application of BDNF

Before application of BDNF

After application of BDNF
Working memory
When building your online courses

- **Chunk**
- **Metaphor**
Next project?

16 five-minute videos:
Microsoft

- Chinese
- Arabic
- Russian
- Spanish
- Norwegian
- Ukrainian
- Portuguese
The down side

The fan letters
We are at the ground floor of a learning revolution!

What are you waiting for?