C Hands-on for Non-CS Students with the Inverted Classroom

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Applied Sciences

C for Non-CS Students

- Practical imperative/procedural programming
- Basic data structures and theory
- 60 students
- 15 x 90 min lecture,
  7 x 90 min seminar, 3 x 3 h lab,
  15 x 90 min student tutors

C for Non-CS Students

- Start with a tiny system and language
- … that can do (sort of) meaningful things
- … and may actually be the real thing, in some cases.
- So: no LEGO Mindstorms, no Arduino

- TI LaunchPad MSP430
- IAR Embedded Workbench (size-limited)

- **Why to flip the class**
- **Technology & technique**
- **Videos for learning**
- **Online activities**
- **A bigger picture**

- **Why to flip the class**
- **Technology & technique**
- **Videos for learning**
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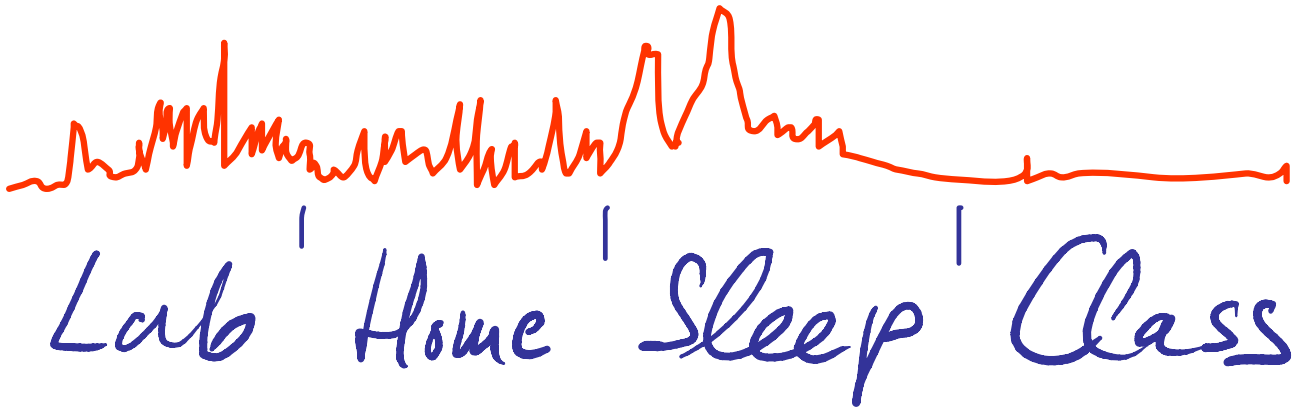
- **A bigger picture**

Lectures are "Relaxing"

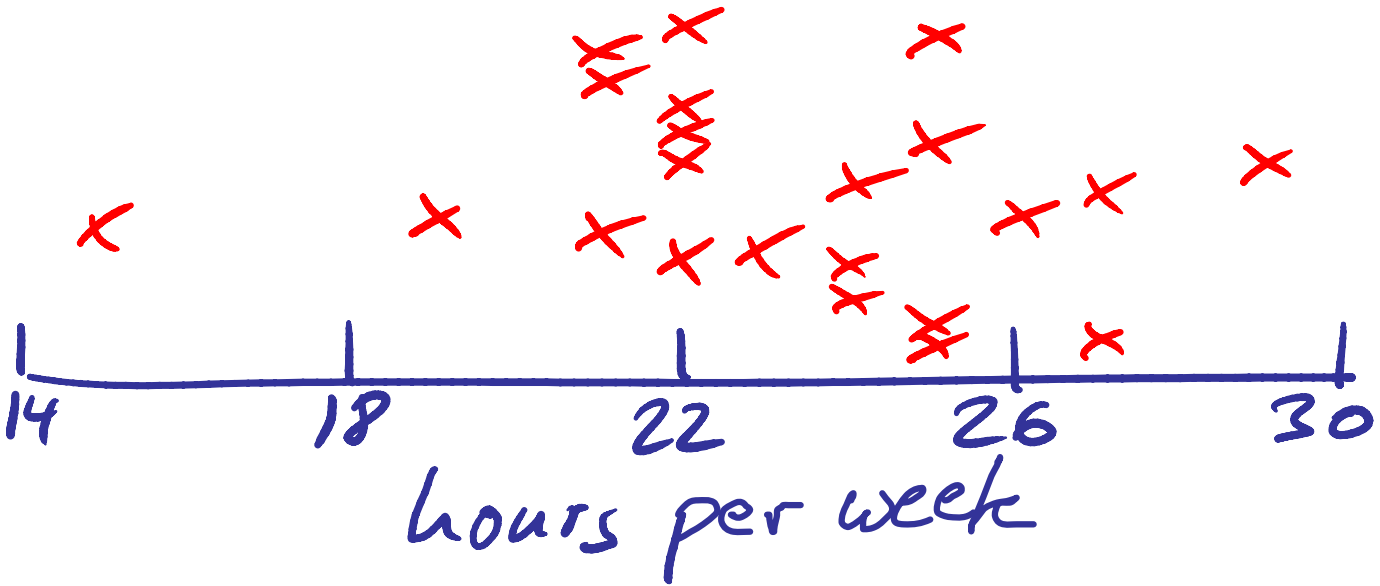


Poh/Swenson/Picard, A Wearable Sensor for Unobtrusive, Long-Term Assessment of Electrodermal Activity. IEEE Trans. Biomed. Eng. 57(5) 1243–1253 (2010)

It's impossible to learn very much by simply sitting in a lecture, or even by simply doing problems that are assigned.

Richard Feynman. Feynman Lectures in Physics, Preface, 1964.

The Workload Delusion



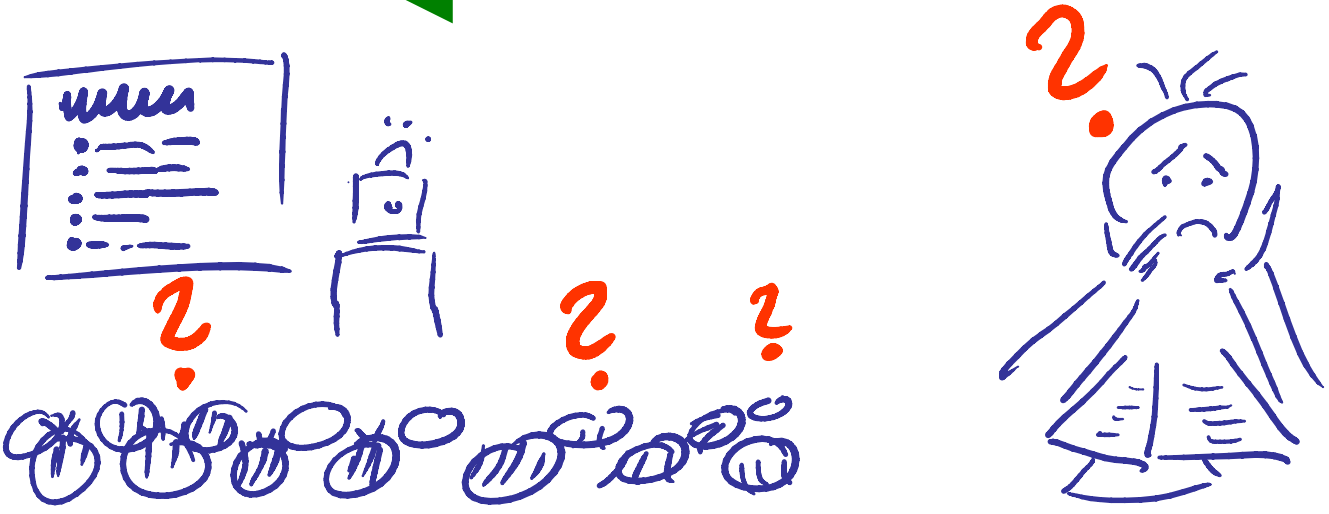
Daten: R. Schulmeister, C. Metzger, T. Martens: Heterogenität und Studienerfolg
http://www.zhw.uni-hamburg.de/zhw/?page_id=419

Lost Time

- What to do without a teacher?
- Homework too complex?
  (Giving up too early?)
- Reading books is antiquated?
- 

Face-to-face: Individually:

Exposition **Practice**



Face-to-face:
Practice + Discovery

Individually:
Exposition

Inverted Classroom Model = Flipped Class

Baker. The Classroom Flip (2000).
Lage/Platt/Treglia. Inverting the Classroom (2000).

03.06 Deklara

Ergänzungen:
03.06a.1 nochmal Funktion, Deklaration, Definition; Aufruf 3:29
03.06a.2 nochmal Funktion 3:29
03A.1 Programmierbeispiel Teil 1, Top-Down-Entwicklung, MSP430 13:28
03A.2 Programmierbeispiel Teil 2, Funktionsdefinition, Funktionsdeklaration
03A.3 Programmierbeispiel Teil 3, Include-Guards, Präprozessor.avi 13:28
03A.4 break, continue, return in Schleifen 12:44
Material
S02B nächste Zweierpotenz, Schleifen, while, do, for 49:59
Material
03B.1 Funktionen in C, Deklaration, Definition; while, do, for 48:03
Material
S03B.1 Fibonacci-Folge, Rekursion, statische Variablen 28:08
S03B.2 C-Funktionen entrümpeln 14:31
Material

Mi, 23. Okt 13 | 4 | Präprozessor, Compiler, Linker
Skript
Material

Grundlagen:
04.01 Übersetzung, Compiler, Interpreter 9:29
04.02.1 Übersetzung von C und C++ 14:03
04.02.2 weiter Übersetzung von C und C++ 4:01
04.03.1 Präprozessor, #include, #define 14:50
04.03.2 weiter Präprozessor, #include-Guards 14:41
04.04 C-Compiler, Fehler, Warnungen 11:24
04.05 Linker, Funktionsnamen 8:07
04.06 Sichtbarkeit static, extern 14:23

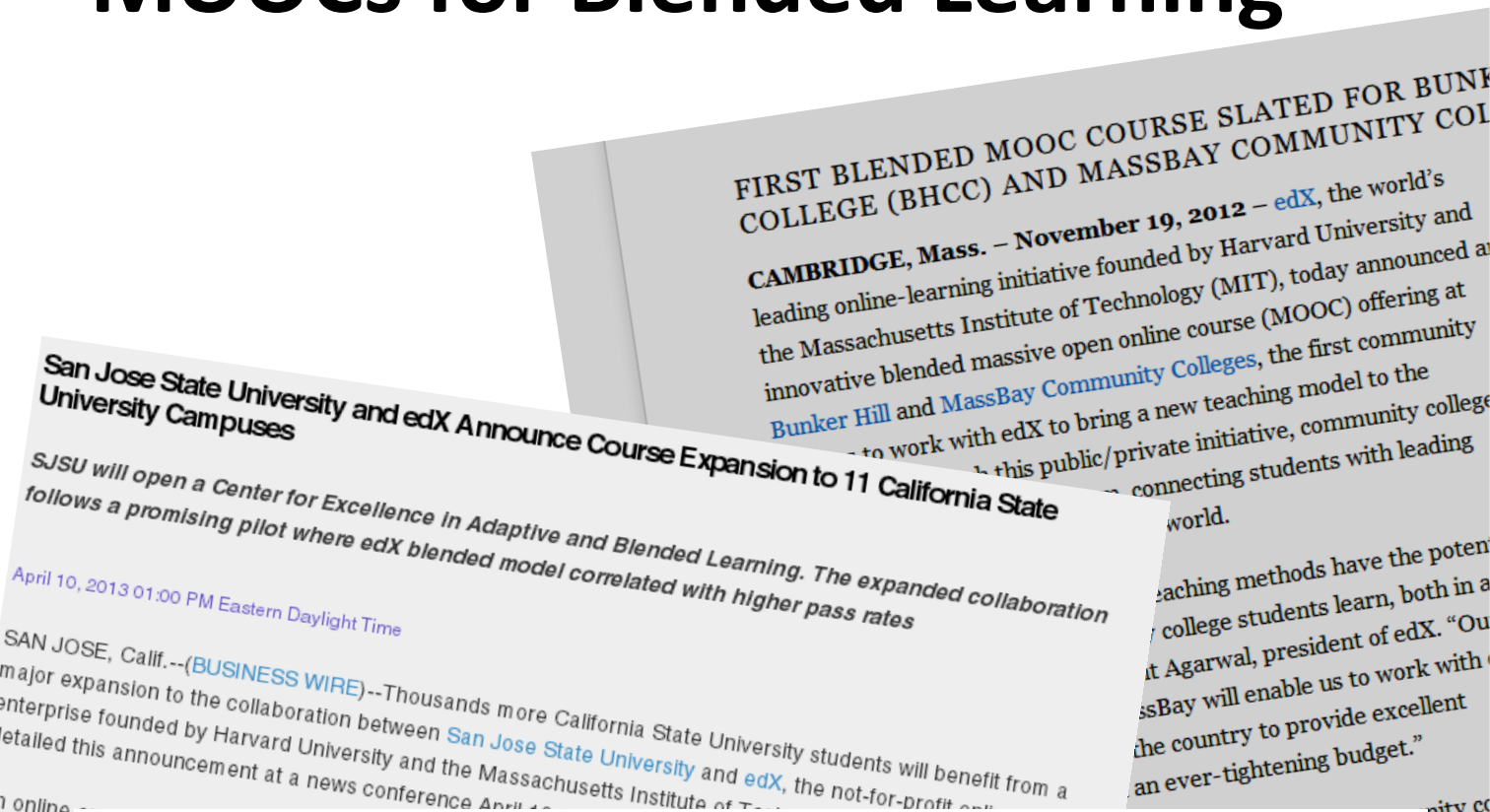
Ergänzungen:
04A.1 Compiler, Linker; Funktionsweise, Fehler9:14
04A.2 static-Variablen in Funktionen 26:39
Material
04B.1 mehrere C-Dateien, Header-Dateien, #include, Include-Guards 55:26
Material
04B.2 extern; zwei Verwendungen von static; Linker-Fehlermeldungen 25:36
Material

atische Funktionen

Flipping the Class, ICM

- Face-to-face: BYOD
  - complex problems
  - deep diagnosis
  - mentoring
- Computer
  - canned explanations
  - simple exercises

MOOCs for Blended Learning



FIRST BLENDED MOOC COURSE SLATED FOR BUNK
COLLEGE (BHCC) AND MASSBAY COMMUNITY COL

CAMBRIDGE, Mass. – November 19, 2012 – edX, the world's leading online-learning initiative founded by Harvard University and the Massachusetts Institute of Technology (MIT), today announced a innovative blended massive open online course (MOOC) offering at Bunker Hill and MassBay Community Colleges, the first community to work with edX to bring a new teaching model to the this public/private initiative, community college connecting students with leading world.

aching methods have the poten college students learn, both in a t Agarwal, president of edX. "Ou ssBay will enable us to work with the country to provide excellent an ever-tightening budget."

San Jose State University and edX Announce Course Expansion to 11 California State University Campuses

SJSU will open a Center for Excellence in Adaptive and Blended Learning. The expanded collaboration follows a promising pilot where edX blended model correlated with higher pass rates

April 10, 2013 01:00 PM Eastern Daylight Time

SAN JOSE, Calif.--(BUSINESS WIRE)--Thousands more California State University students will benefit from a major expansion to the collaboration between San Jose State University and edX, the not-for-profit enterprise founded by Harvard University and the Massachusetts Institute of Technology, detailed this announcement at a news conference April

online
urse for
-- will b
efit thou
as 11 other CSU campuses for the first time last
students from nearly half
San Jose State's
through a $1
grant is part of a $9 million

http://www.businesswire.com/news/home/20130410006022/en/
https://www.edx.org/press/gates-foundation-announcement

My MOOC: Udacity CS222

I'm [redacted] From Tehran, Iran. Live in Kuala Lumpur,Malaysia.

18 years old and this year finished my high school.

I'm [redacted] from Jamaica, West Indies. I am a science educator specializing in biol
me and I'm super excited about the course.

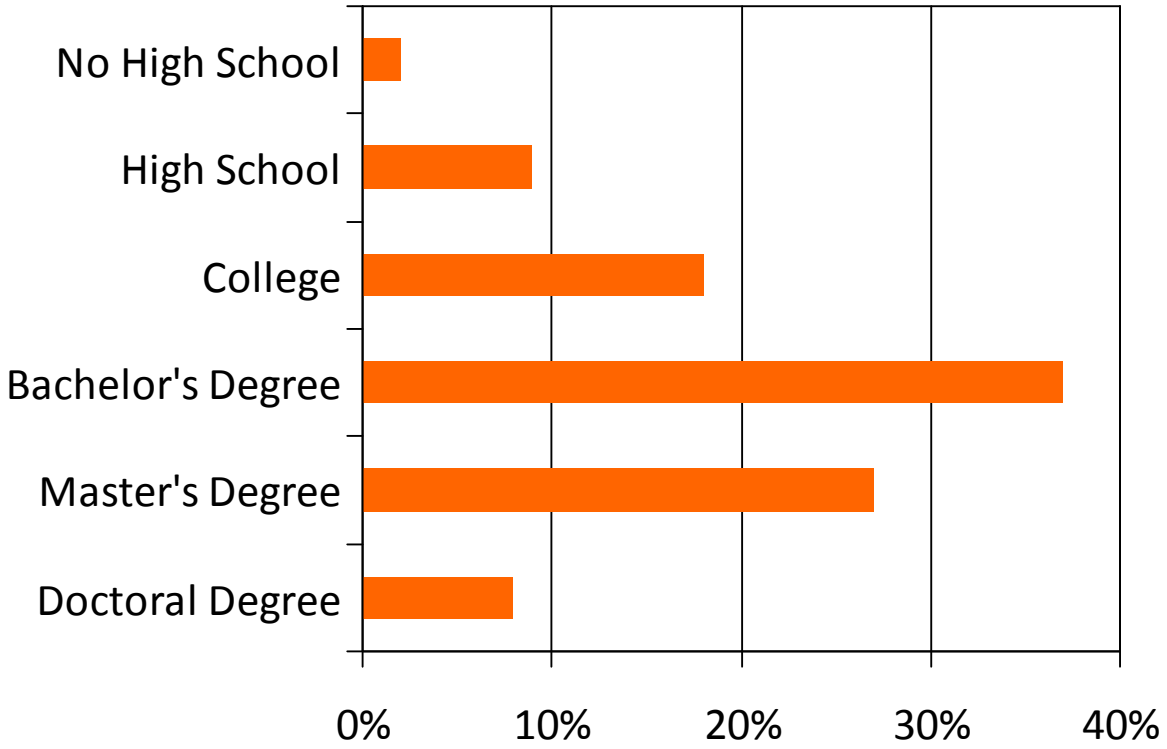
I live in the Houston, Texas area. I was laid off from the Johnson Space Center awhile back.

My job included support for the Space Shuttle, the International Space Station, the Hubble
been in the current Mission Control Center (MCC), as well as visited the historical Mission
missions.

I'm [redacted] I live in Colorado, originally from Moscow, Russia. I was a military officer then
to get structural knowledge about solving differential equations. I'm grateful to Jörn, Miria
to learn great stuff.

http://forums.udacity.com/questions/15000024/where-is-everybody-from#cs222

Another MOOC: Biolelectricity



Daten: http://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/6216/Duke_Bioelectricity_MOOC_Fall2012.pdf

Two Different Audiences

- 100% online doesn't work for most typical students.
- Some blended approaches do.
- Standard MOOCs have a well-educated audience.

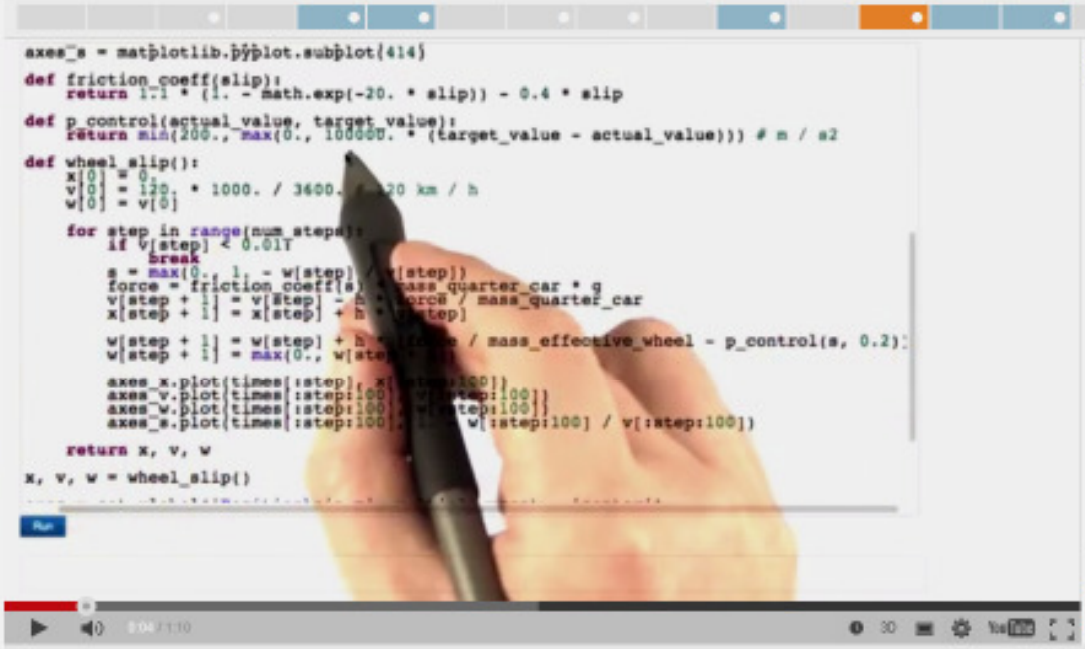
- Why to flip the class
- Technology & technique
- Videos for learning
- Online activities
- A bigger picture

Differential Equations in Action

CLASSROOM

Lesson 5 - Antilock Braking Systems

Edit | Edit (New)



P Controller Solution

Back to Quiz

Continue

Discussions

See All

60 m to braking ? Oct 1, 2012

Ask a Question

Instructor Notes

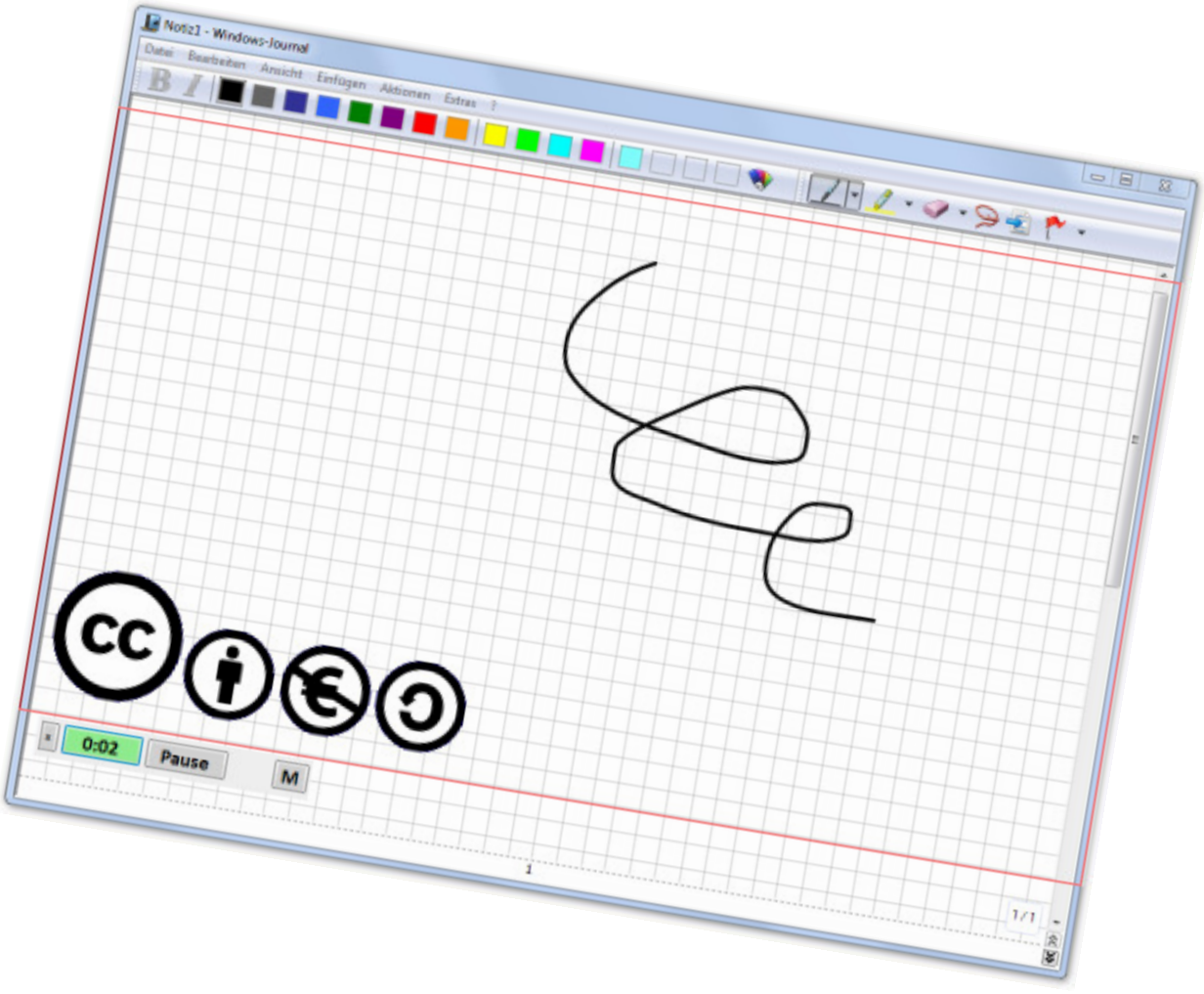
No additional notes for this section

Studio in the Classroom

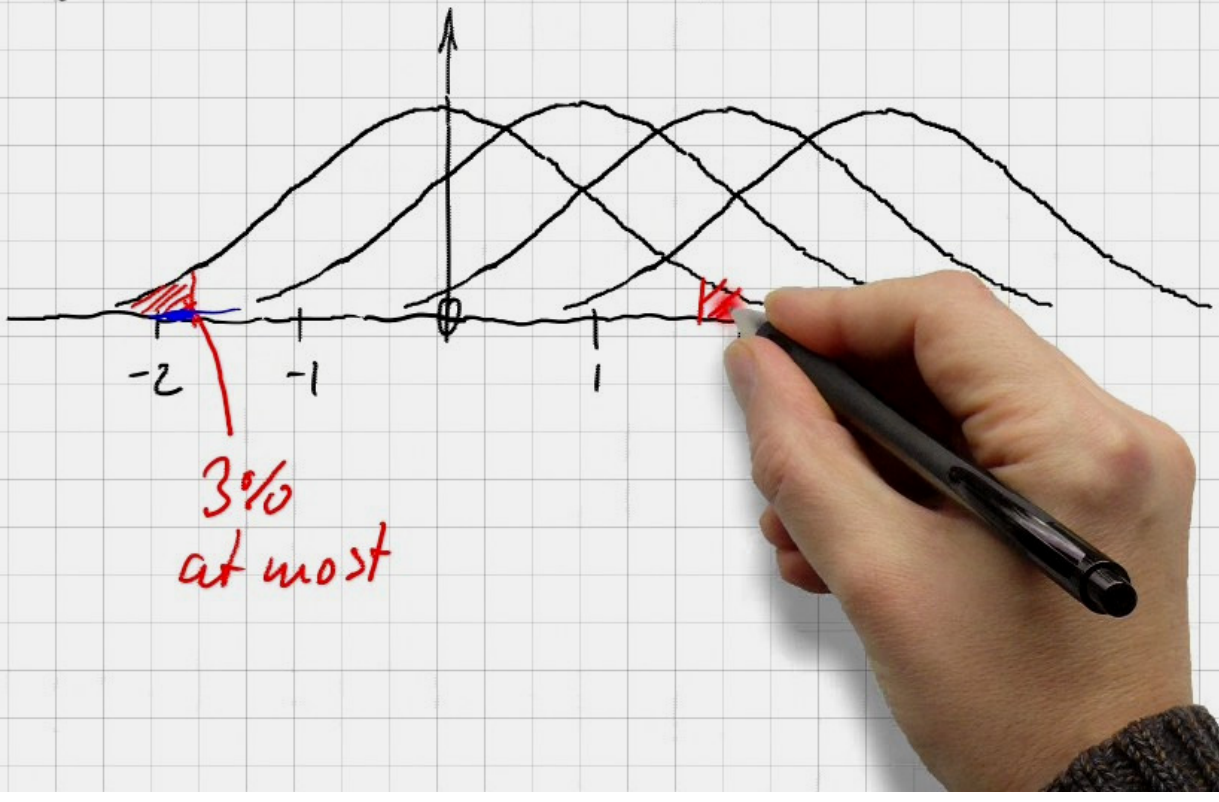
The Digital Whiteboard

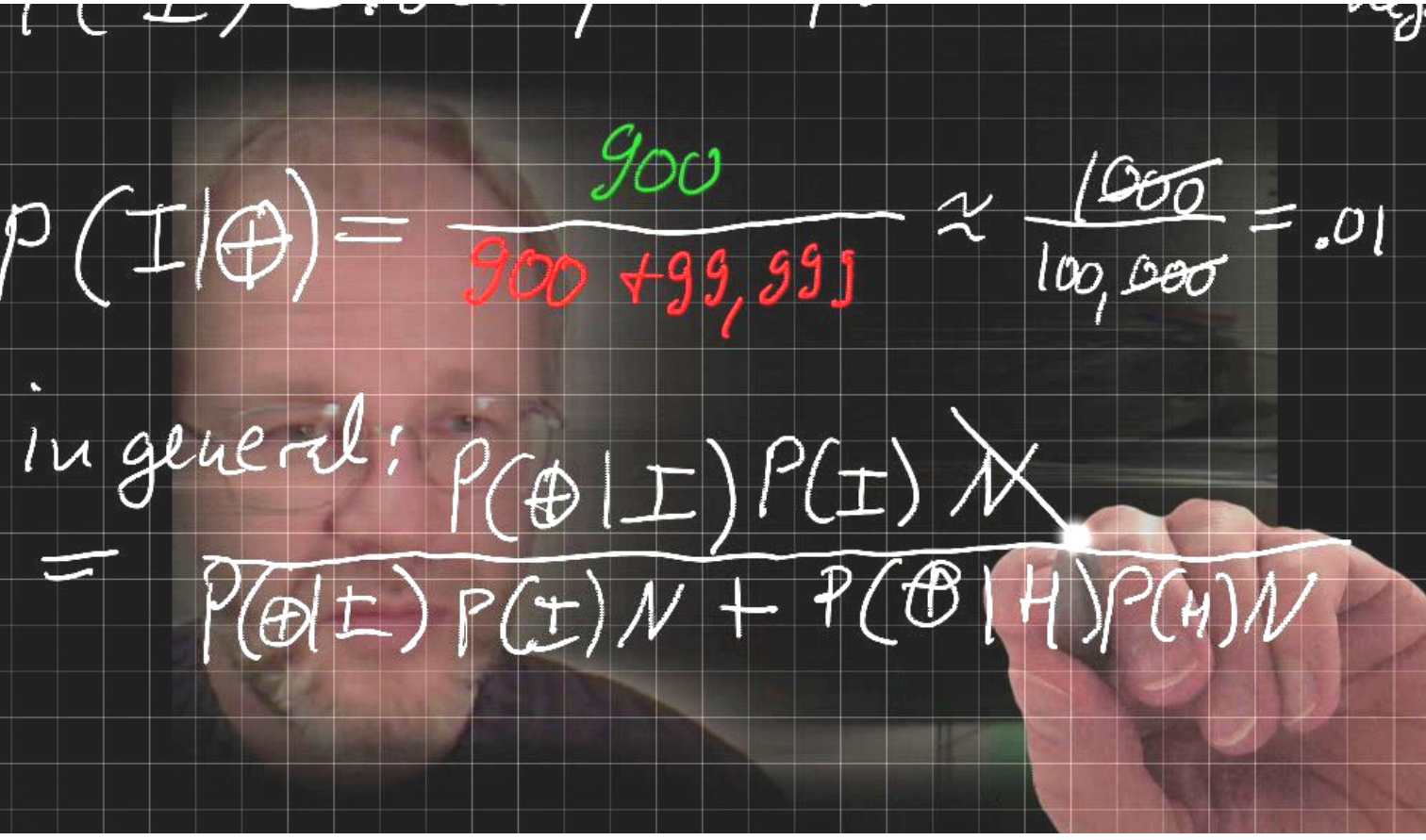
- Scribbles, derivations, …
- IDE in action: debugging etc.
- Results via webcam

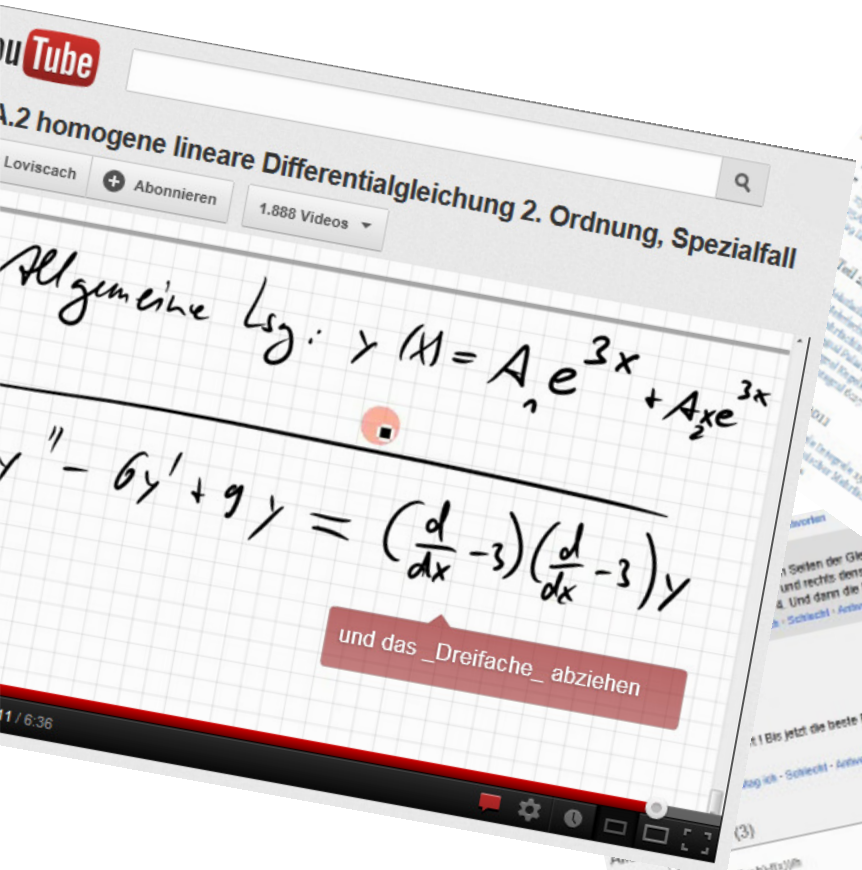
DEMO

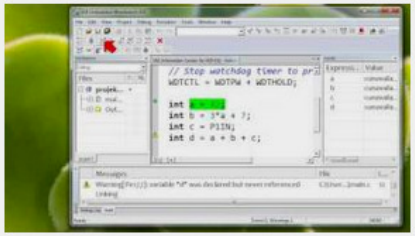

Notiz1 - Windows-Journal
Datei Bearbeiten Ansicht Einfügen Aktionen Extras ?
0:02
Pause
M
1
1/1

P ($t = -1.82$ or worse) = ?




P(I|⊕) = 900 / (900 + 99,999) ≈ 1000 / 100,000 = .01
in general:
= P(⊕|I) P(I) N / (P(⊕|I) P(I) N + P(⊕|H) P(H) N)


YouTube
A.2 homogene lineare Differentialgleichung 2. Ordnung, Spezialfall
Loviscach
Abonnieren
1.888 Videos
Allgemeine Lsg: $y(x) = A_1 e^{3x} + A_2 x e^{3x}$
$y'' - 6y' + 9y = \left(\frac{d}{dx} - 3\right)\left(\frac{d}{dx} - 3\right) y$
und das _Dreifache_ abziehen
1 / 6:36



Programmierung in C und MATLAB(R), Beschreibungsverfahren, Ideen des Software Engineering, Ideen der Theoretischen Informatik

Über diesen Kurs

Google Videos: 110

Dauer: 19 Stunden

Über den Videokünstler

Jörn Loviscach
2.426 Videos
28.433 Abonnenten

Informatik 1, Winter 2010/2011

Vorträge in diesem Kurs (110)

Gerade abgespieltes Video ausblenden

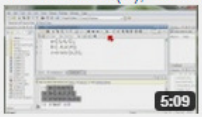
Alle ansehen

S01 TI LaunchPad, erstes Programm

Alle Videos hintereinander in der Playliste zu Informatik 1, Winter 2010/2011: http://www.youtube.com/joernloviscach#g/p Skripte, Aufgaben, Links: http://www.j3l7h.de/lectures/1011ws/Informatik_1/

28.275 Aufrufe

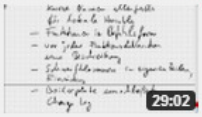
S02 MATLAB(R), erstes Programm



Alle Videos hintereinander in der Playliste zu Informatik 1, Winter 2010/2011: http://www.youtube.com/joernloviscach#g/p Skripte, Aufgaben, Links: http://www.j3l7h.de/lectures/1011ws/Informatik_1/

10.581 Aufrufe

14.02 Code Conventions, Styleguides, ungarische Notation, MISRA



Alle Videos hintereinander in der Playliste zu Informatik 1, Winter 2010/2011: http://www.youtube.com/joernloviscach#g/p Skripte, Aufgaben, Links: http://www.j3l7h.de/lectures/1011ws/Informatik_1/

1.932 Aufrufe

14.03 defensive Programmierung, assert

Alle Videos hintereinander in der Playliste zu Informatik 1, Winter 2010/2011: http://www.youtube.com/joernloviscach#g/p Skripte, Aufgaben, Links: http://www.j3l7h.de/lectures/1011ws/Informatik_1/

1.878 Aufrufe

Efficiency

- Record in front of an audience:
  focus, ethusiasm,
  tolerate glitches
- Don’t edit.
- Don’t review from A to Z.

Efficacy

- Interleave tasks for the audience, look at results:
  don’t fly too high.
- Record problems & solutions from the face-to-face phase:
  (complex) worked examples.

  DEMO

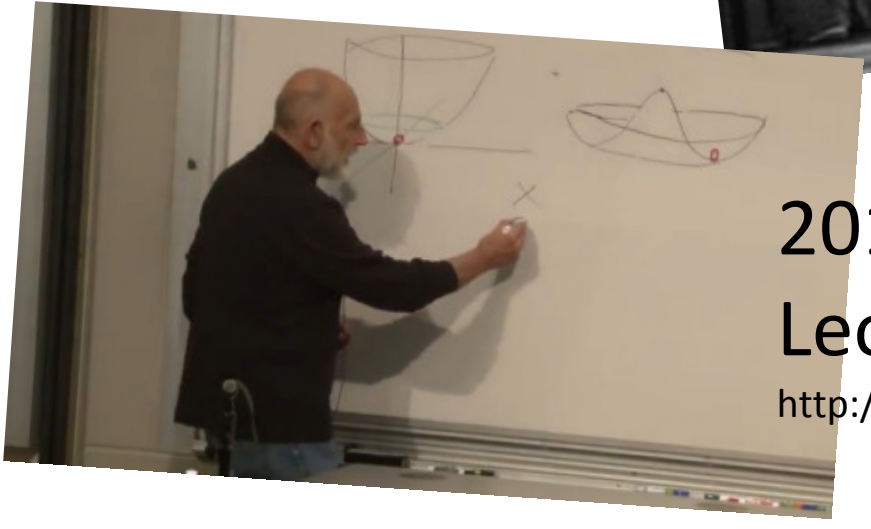
- Why to flip the class
- Technology & technique
- Videos for learning
- Online activities
- A bigger picture

Lecture Recordings

1964

Richard Feynman

http://research.microsoft.com/tuva



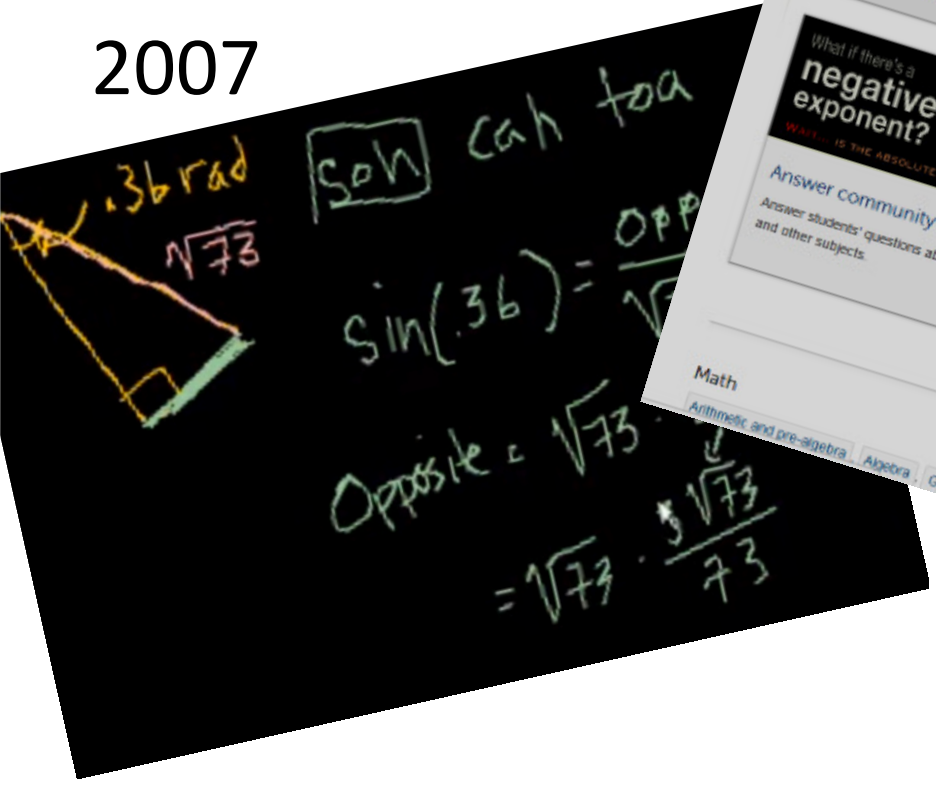
2012

Leonard Susskind

http://youtu.be/JqNg819PiZY

Salman Khan

2007



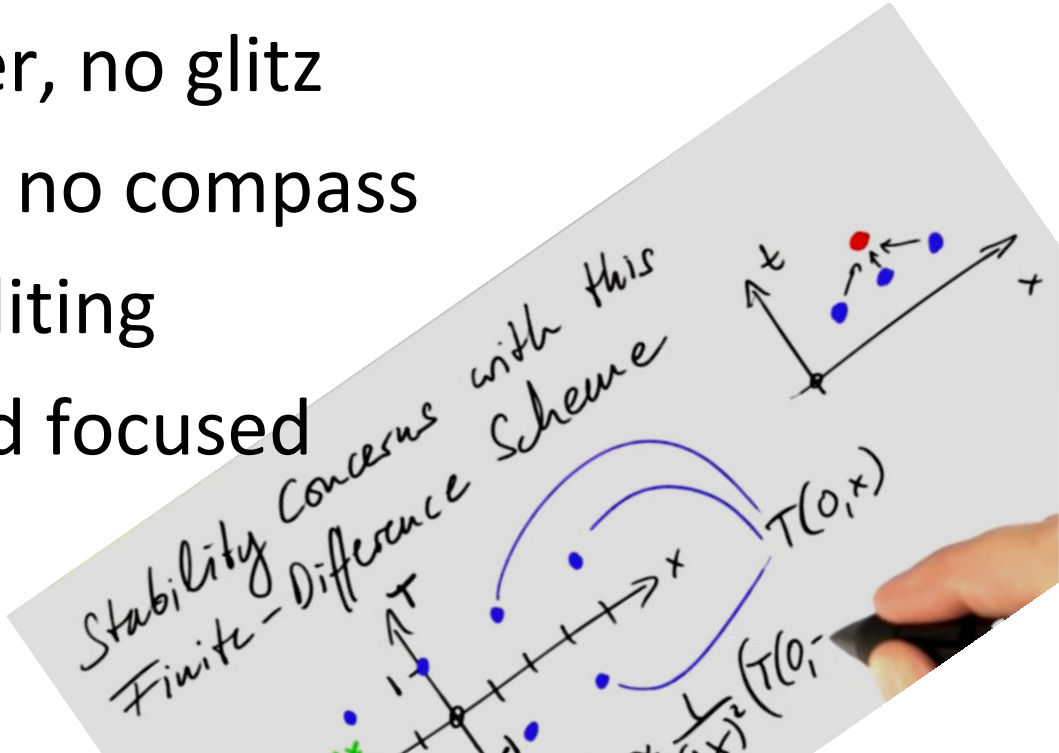
2013

http://youtu.be/RoXmKYjpLGk

https://www.khanacademy.org/

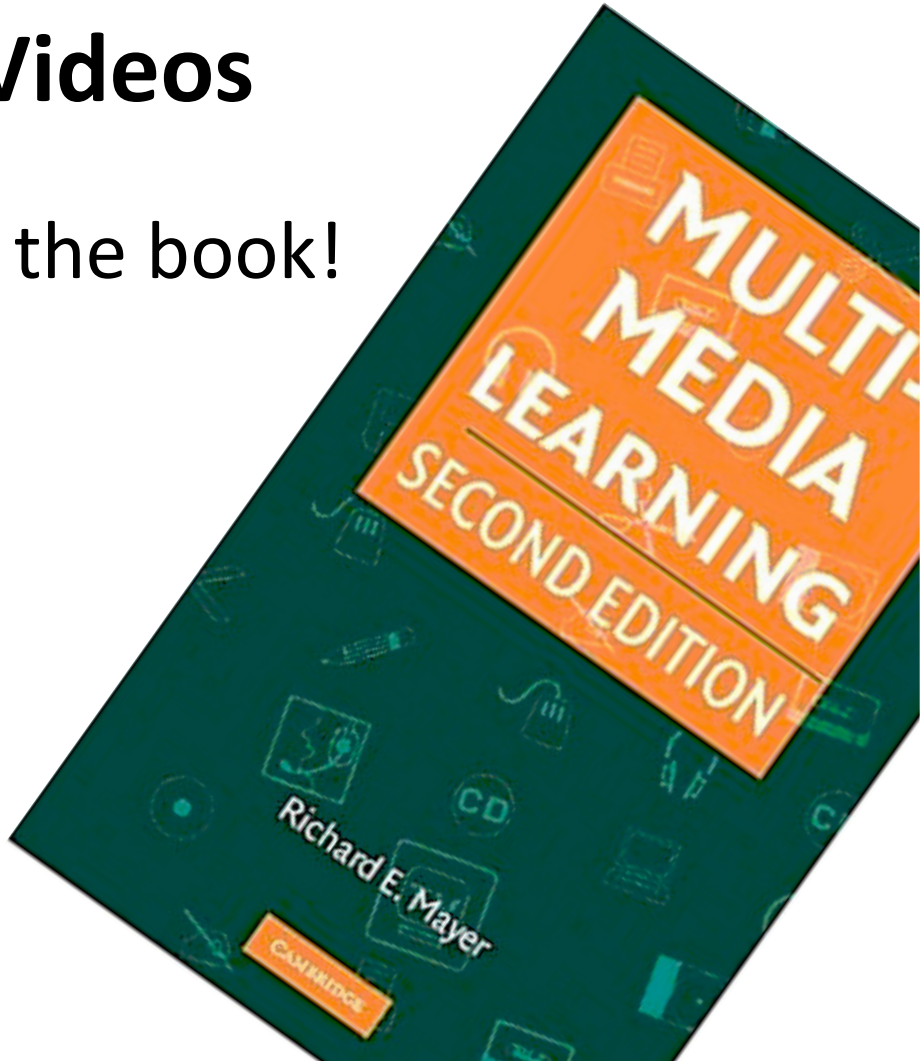
Khan-Style Videos

- Informal, colloquial, authentic
- No clutter, no glitz
- No ruler, no compass
- No (?) editing
- Short and focused



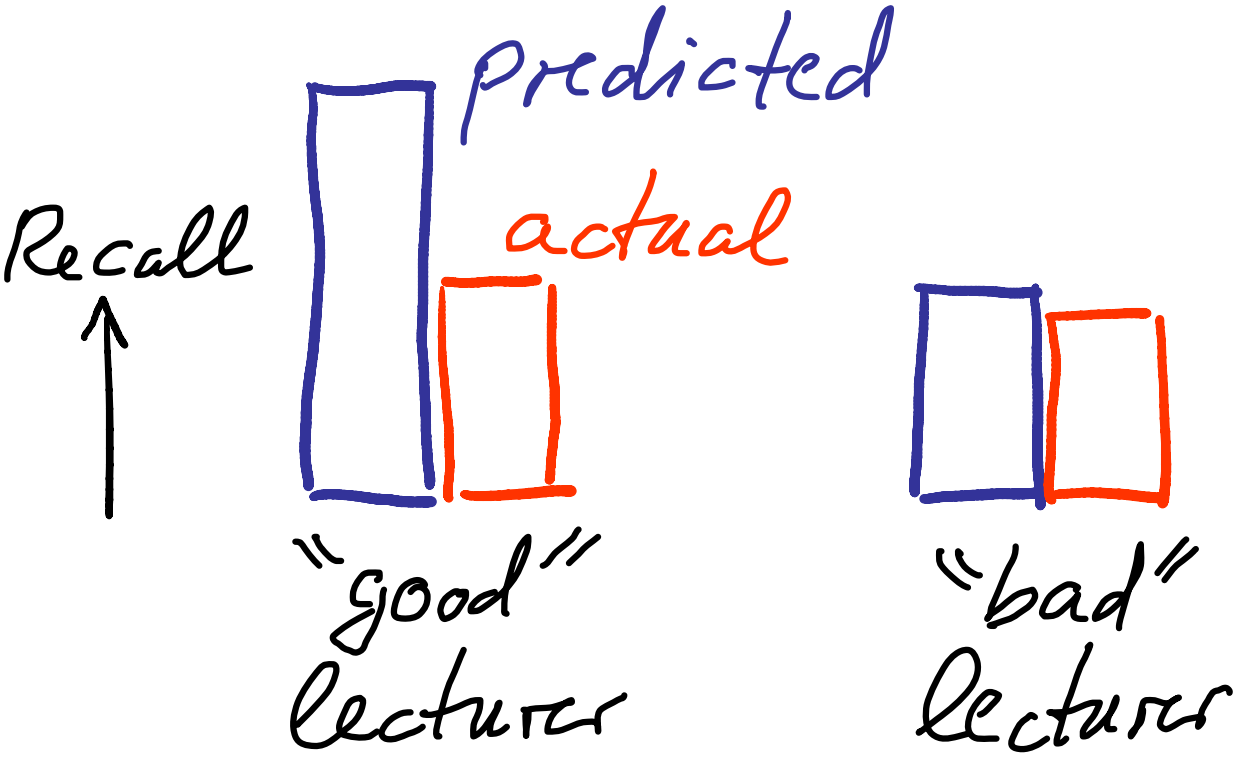
Khan-Style Videos

Multimedia by the book!




DANGER
EJECTION
SEAT
DANGER
DANGER

Star Professors?!



Carpenter/Wilford/Kornell/Mullaney. Appearances can be deceiving: Instructor fluency increases perceptions of learning […]. Psych. B&R 2013.

Understanding?!

- "Perfect" videos can promote misunderstandings.

  Derek Muller. Designing effective multimedia for physics education. PhD Thesis University of Syndey, 2008.

- The less you know, the more you overrate your competency.

  Dunning/Johnson/Ehrlinger/Kruger. Why people fail to recognize their own incompetence. Curr. Dir. Psy. Sc. 12(3), 83–87, 2003.

Self-Reports of Learning?!

- “Yeah, sure, I can do that. ”?
- Questionnaires?
- “Like it”?

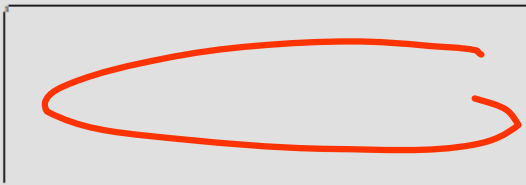
- Why to flip the class
- Technology & technique
- Videos for learning
- **Online activities**
- A bigger picture

Lean Backward

Lean Forward

Worksheets etc.

- Write and draw: retention
- Value due to one's own contribution
- Fight distractions



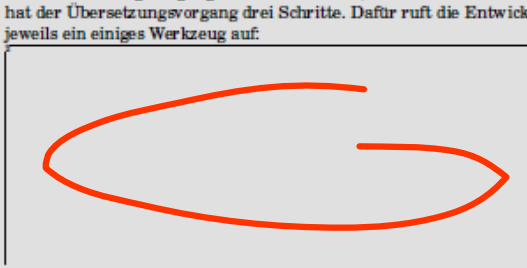
Skriptsprachen sind typischerweise von der ersten Sorte, „vollwertige" Pro
miersprachen von der zweiten.

Diese harte Unterscheidung ist aber längst veraltet: Skriptsprachen wie J
cript werden zur Beschleunigung bei der Ausführung in Maschinensprac
wandelt (Just-in-Time Compiler). Die üblichen Compiler für die „vollwer
Programmiersprachen Java und C# erzeugen keine Maschinensprache (
code), sondern die Sprache einer virtuellen Maschine (Bytecode bzw. Intern
te Language). Diese Sprache wird interpretiert (wieder mit einem Just-in-
Compiler) bzw. beim ersten Programmstart in Maschinensprache übersetzt.

Anmerkung am Rande: Alle gängigen Programmiersprachen verwenden fü
Quellcode normale Textdateien. Die Namen der Dateien enden dann zwar
.cpp, .java, .cs, .js usw., aber man kann die Dateien trotzdem mit einem Tex
öffnen. Nicht dagegen den kompilierten Code, zum Beispiele eine .exe-Datei
Windows! (Demo)

2 Übersetzungsvorgang in C und C++

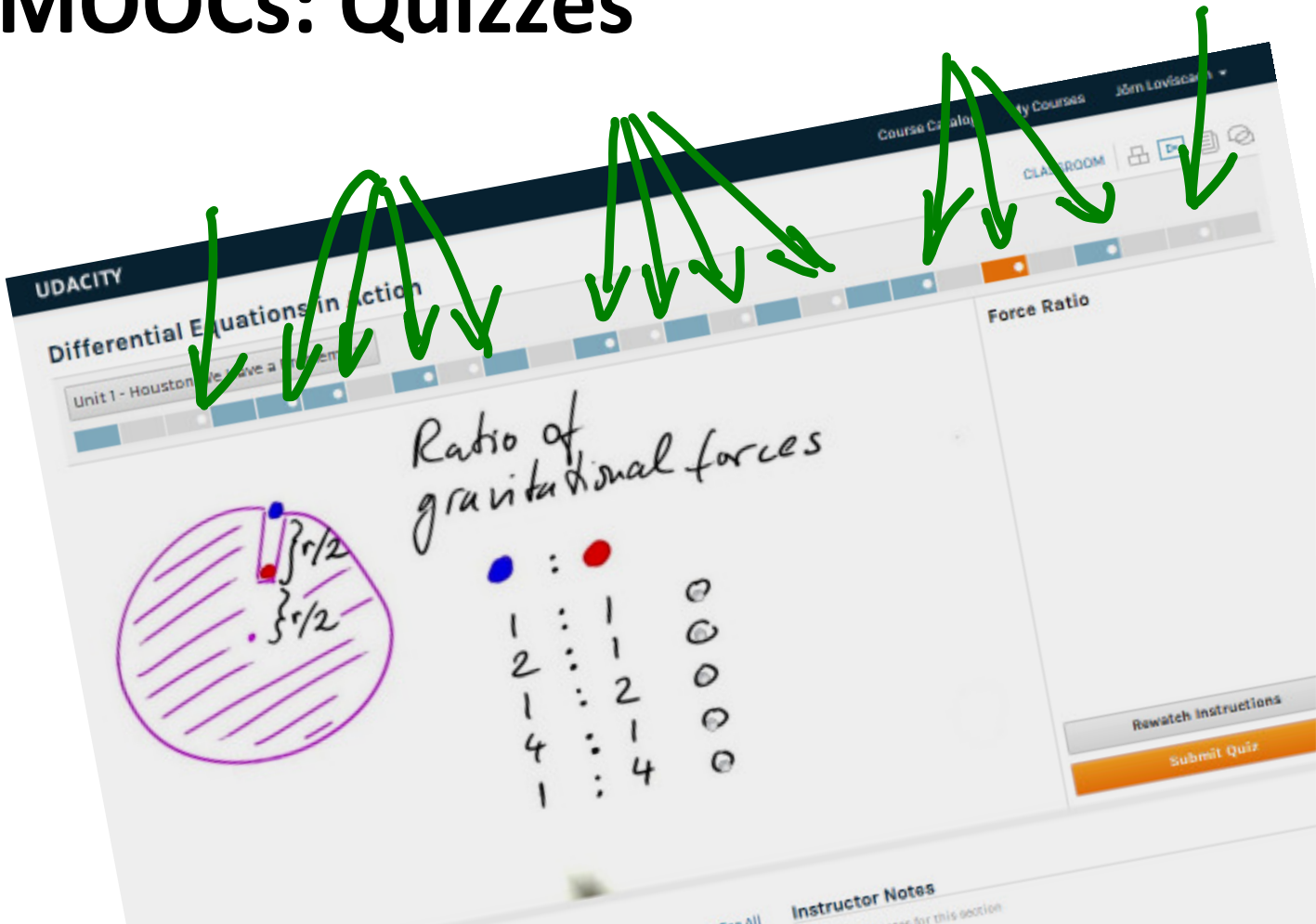
In den Sprachen C und C++ bekommt man anders als in modernen Sprache
vom Übersetzungsvorgang mit – meist mehr, als einem lieb ist. In C un
hat der Übersetzungsvorgang drei Schritte. Dafür ruft die Entwicklungsg
jeweils ein einiges Werkzeug auf:



In den üblichen Entwicklungsumgebungen wie der IAR Embedded Workb
oder Microsoft Visual Studio passiert alles drei beim Klick auf Run, Debug,
Rebuild oder Erstellen automatisch hintereinander.

Warum diese Arbeitsteilung? Der Präprozessor sah früher mal wie eine gut
aus, um Programmcode automatisch umzuformen. In Java und anderen mod

MOOCs: Quizzes



Which Effect is included here?

$$\dot{S}(t) = -\frac{5\times10^{-9}}{\text{day}\cdot\text{person}} I(t) S(t) + 1000 \frac{\text{persons}}{\text{day}}$$

$$\dot{I}(t) = \frac{5\times10^{-9}}{\text{day}\cdot\text{person}} I(t) S(t) - \frac{1}{5\,\text{days}} I(t)$$

$$\dot{R}(t) = \frac{1}{5\,\text{days}} I(t)$$

- Vaccination
- Births
- Immigration
- Deaths

Adding Susceptibles

Rewatch Instructions

Submit Answer

Discussions See All

Reason for ruling out births makes no sense for short timeframe out a

Ask a Question

Instructor Notes

No additional notes for this section

Central-Difference Formulas for Derivatives

$$f''(x_0) \approx \frac{f(x_0-\Delta x)+f(x_0+\Delta x)-2f(x_0)}{(\Delta x)^2}$$

$$f''''(x_0) \approx \frac{1}{(\Delta x)^4}\left(\begin{array}{l} \square\, f(x_0-2\Delta x) \\ +\ \square\, f(x_0-\Delta x) \\ +\ \square\, f(x_0) \\ +\ \square\, f(x_0+\Delta x) \\ +\ \square\, f(x_0+2\Delta x) \end{array}\right)$$

Fourth Derivative

Rewatch Instructions

Submit Answer

Continue to Answer

Discussions See All

Unit6-7 Grader Error

Ask a Question

Instructor Notes

No additional notes for this section

Differential Equations in Action

Problem Set 1

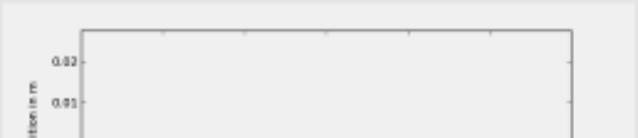
```
# PROBLEM 2
#
# Modify the trajectory function below to
# plot the trajectory of several particles.
# Each trajectory starts at the point (0,0)
# given initial speed in the direction
# specified by the angle. Use the Forward
# Euler Method to accomplish this.

import math
from udacityplots import *

h = 0.1 # s
g = 9.81 # m / s2
acceleration = numpy.array([0., -g])
initial_speed = 20. # m / s

@show_plot
def trajectory():
    angles = numpy.linspace(20., 70., 6)

    num_steps = 30
    x = numpy.zeros([num_steps + 1, 2])
    v = numpy.zeros([num_steps + 1, 2])

    for angle in angles:
        ###Your code here.

        matplotlib.pyplot.plot(x[:, 0], x[:, 1])
    matplotlib.pyplot.axis("equal")
    axes = matplotlib.pyplot.gca()
    axes.set_xlabel("Horizontal position in m")
    axes.set_ylabel("Vertical position in m")
    return x, v
```

Ballistic Trajectories

Rewatch Instructions

Submit

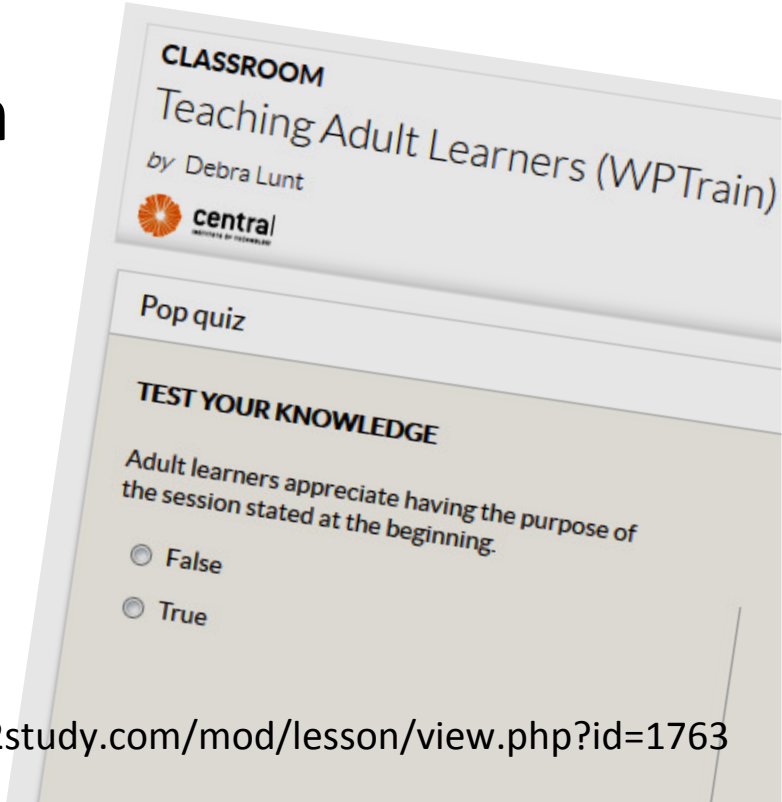
Reset Test Run



Quizzes for Focus

Szpunar/Khan/Schacter. Interpolated memory tests reduce mind wandering and improve learning of online lectures. PNAS, April 2013.

- Dead-man switch
- Not too basic, please



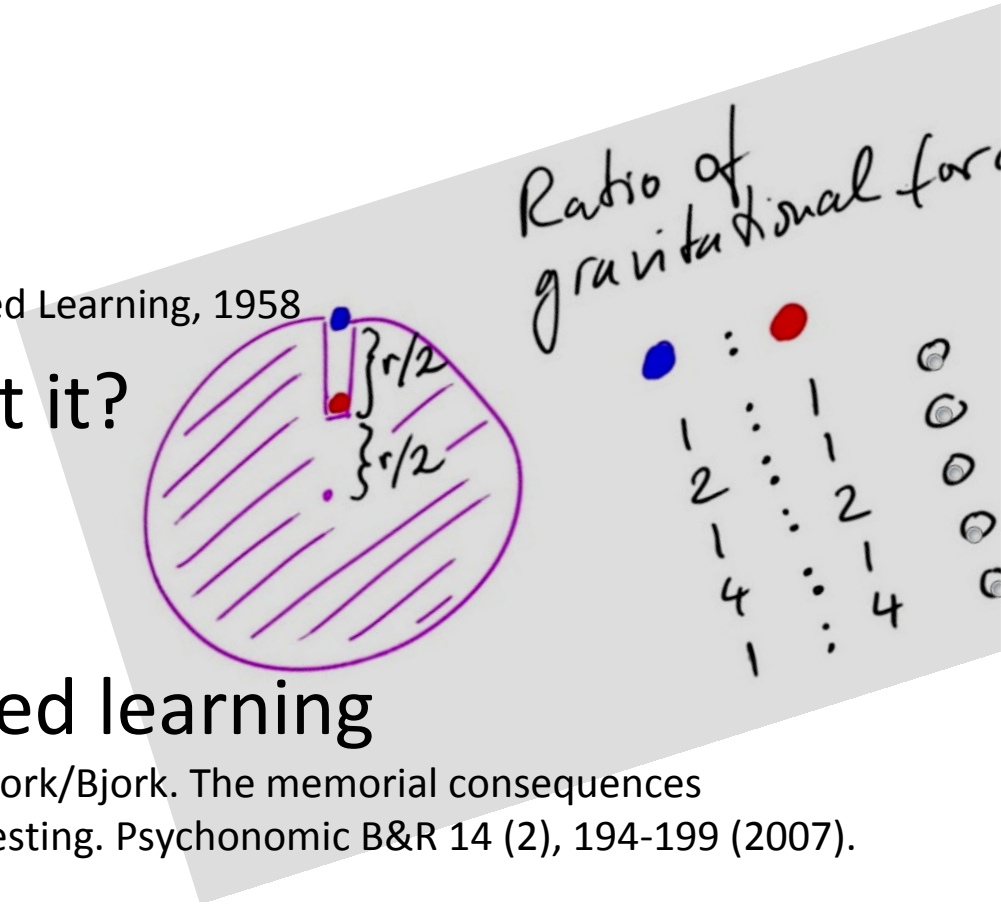
https://learn.open2study.com/mod/lesson/view.php?id=1763

Exercises

- Skill & Drill

  Skinner: Programmed Learning, 1958

- Did you get it?



- Test-induced learning

  Marsch/Roediger/Bjork/Bjork. The memorial consequences of multiple-choice testing. Psychonomic B&R 14 (2), 194-199 (2007).

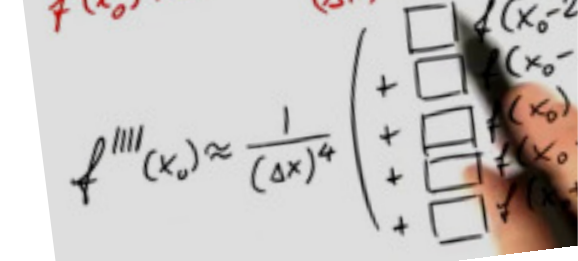
Fostering Deep Learning

- Strategy: What's the next step?
- Self-explanations, possibly with peer review

  Roy/Chi. The Self-Explanation Principle. In: Mayer. Cambridge Handbook of Multimedia Learning, 271-286, 2006.

- Discovery learning

  But: This is easy for some students but very demanding for most.

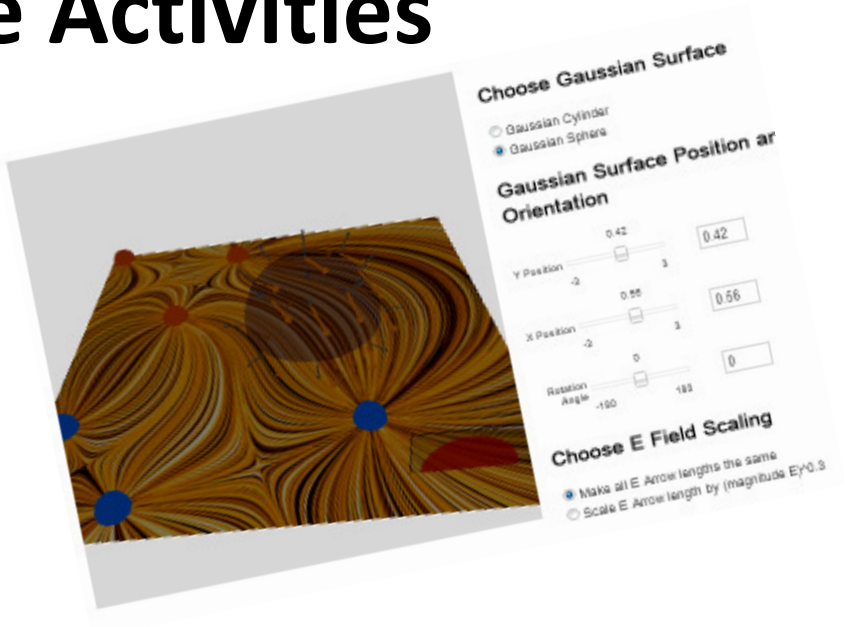


Software and quizzes by Robin Woll

- Quizzes within the video
  - What's the next step
  - Simple exercises
  - Prompts for self-explantions
- Gamification

More Online Activities

- Simulations
  - roll your own
  - canned
- Forum, chat
- Peer review
- Group viewing
- …



https://www.edx.org/courses/MITx/8.02x/2013_Spring/courseware/Week_1/tealsim_gauss/

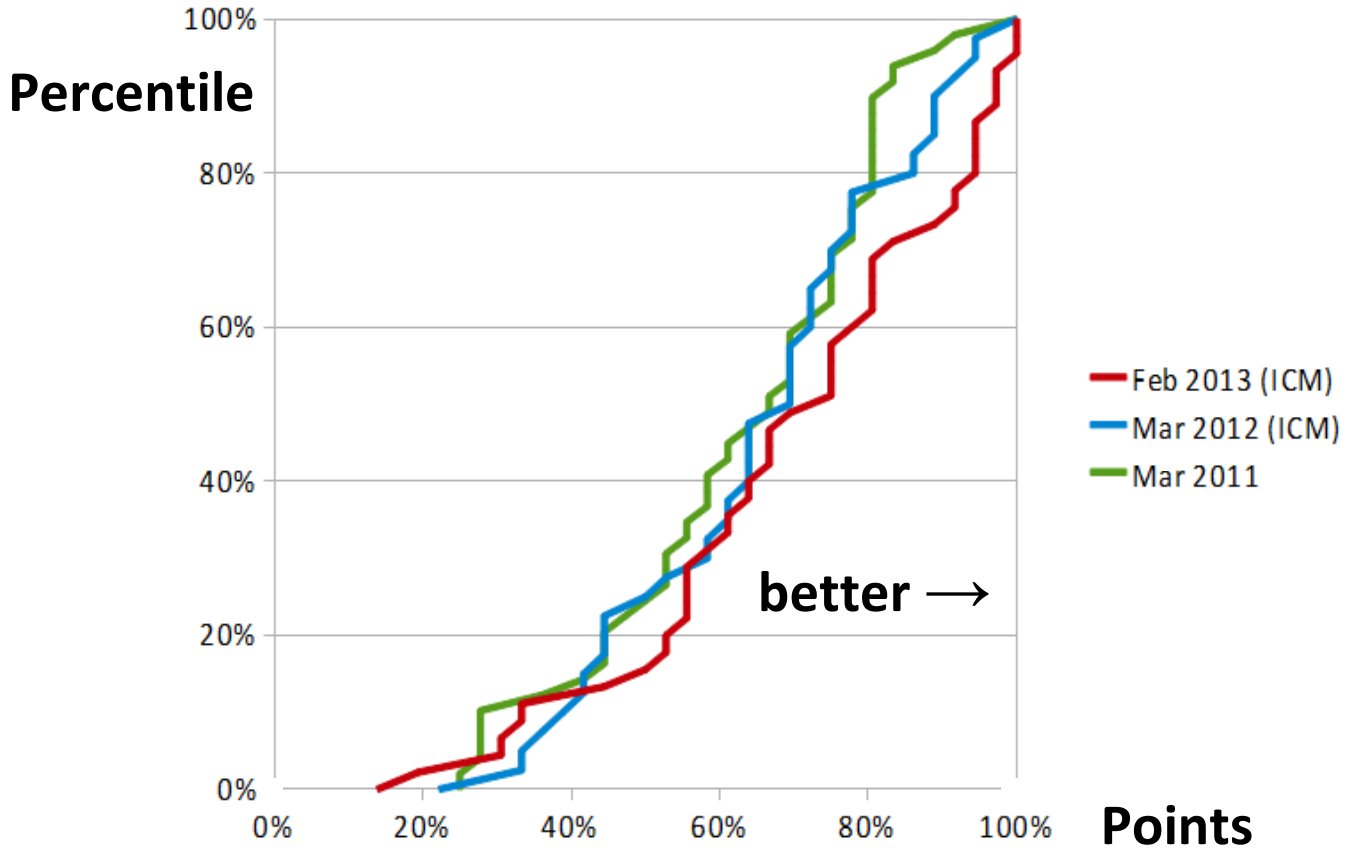
- Why to flip the class
- Technology & technique
- Videos for learning
- Online activities
- A bigger picture

Does It Work?

Benefits

- Far more supervised practice
- Far more immediate feedback
- Far less Facebook and Whatsapp in class
- Far more topical discussions with and among students during class
- More fun

Exam Results



Why no Bigger Effect?

- No quizzes for the videos – yet
- Standard written exam fosters superficial learning
- Challenged students focus on other subjects first

Are Videos and Quizzes Academic Education?

- Spoonfeeding?
- No more reading?
- Oversimplification?
- Too few “desirable difficulties”?

  Bjork/Dunlosky/Kornell. Self-Regulated Learning: Beliefs, Techniques, and Illusions. Annu. Rev. Psychol 64, 417-444 (2013).

- Too little “invested mental effort”?

  Salomon. Television is “easy” and print is “tough”.
  J. Ed. Psychology 76(4), 647-658 (1984).

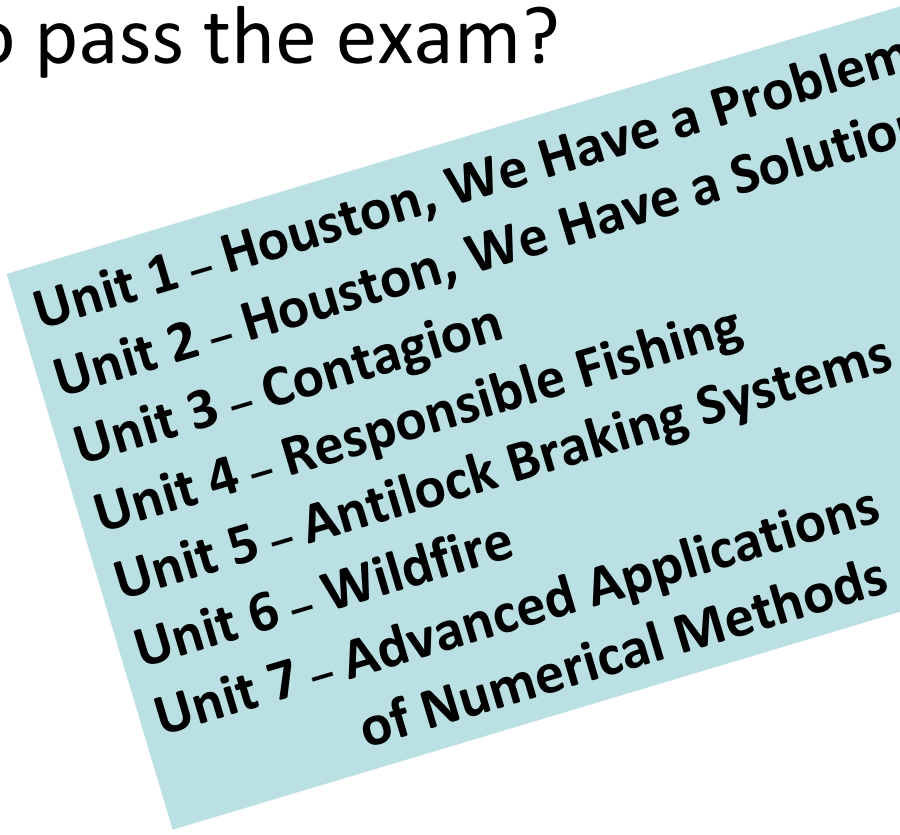
Subject Matter is King?

- Force Concept Inventory, 1985
- Harvard "A Private Universe", 1987
- An engineer: *Squared or cubed is the most complex thing you do.*

  Kent/Noss. The mathematical components of engineering expertise. Engineering Education 2002.

Subject Matter is King?

- 50% suffice to pass the exam? Mastery?!
- "Elementitis" (D. Perkins) vs. "Story-Centered Curriculum" (R. Schank)



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