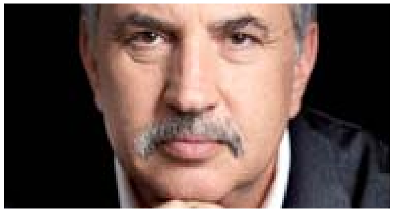
The New York Times

Op-Ed Columnist
By THOMAS L. FRIEDMAN
Published: May 15, 2012



Come the Revolution

Welcome to the college education revolution. Big breakthroughs happen when what is suddenly possible meets what is desperately necessary. The costs of getting a college degree have been rising faster than those of health care, so the need to provide low-cost, quality higher education is more acute than ever. At the same time, in a knowledge economy, getting a higher-education degree is more vital than ever. And thanks to the spread of high-speed wireless technology, high-speed Internet, smartphones, Facebook, the cloud and tablet computers, the world has gone from connected to hyperconnected in just seven years.

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Reform or Revolution?
Undergraduate Science Education
in Diverse Contexts of Learning

Larry Flick
Professor of Science Education
Colleges of Education & Science
Dean of College of Education

Major Premise:
Reform in collegiate science education is embedded in large social and professional systems that are being impacted by the rapid growth of information technologies and changing economic conditions

Two points in the talk:

- Confluence of K12 STEM education research with similar work in higher education
- Revolution in information access, presentation, and sharing

Point 1
College Science Education
Confluence of issues affecting K12 and Collegiate education

- Cost of higher education
- Student debt
- Accreditation requirements
- Impact of educational research – NGSS & CCSSM

NEXT GENERATION SCIENCE STANDARDS

COMMON CORE STATE STANDARDS INITIATIVE
PREPARING AMERICA'S STUDENTS FOR COLLEGE & CAREER

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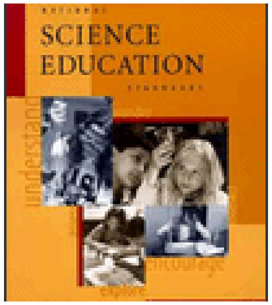
National Science Education Standards (1996)



- A revolution that didn't happen
- Science as inquiry became a forerunner – in advance of the messenger rather than the messenger itself
- Inquiry was largely incorporated into standard modes of practice
- Classroom expression remained of largely teacher understandings and not student understandings

Next Generation Science Education Standards (2012)

- Not tweaking but changing the nature of STEM teaching
- Foregrounds discourse in discipline-based practices
- Science & Mathematics education becoming STEM education
- Combining new components: Inquiry, Engineering, Computation

Scientific & Mathematical practices – theory of change

- IF: Establish a compelling context for learning science
- IF: Instruct students in structured discourse embedded in the practices of the discipline; scaffolds expression of their own thinking
- IF: Instruct students in critiquing the thinking of others, and teacher uses selected student ideas to highlight central content
- THEN: Students see knowledge as a human construction
- THEN: Test knowledge against their own understanding of evidence from the world
- THEN: Appropriate ideas within the context of their own reasoning for long-term retention

Conceptual framework for Collegiate Science Education

Engaging students in "knowledge work"

Goodyear & Ellis (2011); Goodyear & Zenios (2007)

Reform in Undergraduate Science directs student participation in the work of building knowledge through various forms of discourse rather than just reflecting on completed achievements

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Examples of Epistemic Forms in Science Education

Inquiry

Interpreting models

Making models

Using models to form an explanation, a problem

Argumentation

Use of evidence

Generalizations

Justification

Articulating a theory

Stating or finding a “problem”

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Goodyear & Ellis (2011);
Goodyear & Zenios (2007)

Personal mental flexibility of conceptual learning in science is insufficient

Collins & Ferguson, (1993): **Cook & Brown's (1999)**

Linking Lab, Lecture, and Recitation & Online resources and networking

- Operationally this means to inoculate students in all 4 settings by:
- Seeing models,
- Engaging in practice toward well established goals
- Getting feedback on incremental improvement in the use of discourse used in scientific practices
- Instruction that fosters independent skill use

(Palincsar & Brown 1989; Lave & Wenger, 1991)

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Point 2
Revolution in information access, presentation, and sharing

Examples from the Current Landscape of Innovation in University Teaching, Course Design, and instructional environments

(Kirschner, 2012)

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- Kahn Academy – catalog of instructional elements - In the last 18 months there were 41 million visitors in the US alone.
- Candice Thille – online delivery of content that collects data on student learning to inform face-to-face instruction
- Fedora [Flexible Extensible Digital Object Repository Architecture], HathiTrust [*10 million volumes draws on more than 60 partner institutions*], Google Books, Project Gutenberg – online repositories of the worlds information (available to everyone all the time)
- Kathleen Fitzpatrick – changing the environment for scholarship and peer review

University perception of market dominance make leaders oblivious to change.

Analogy to video recording industry

- 1970s video recording became a major contributor to the television industry
- 1997 DVD-Video format introduced
- 2006, studios in the US stopped releasing new movie titles in VHS format
- 2011 High-capacity digital recording technologies are currently replacing DVD

Changing Minds

Harry M. Warner of Warner Brothers in 1927 commenting on the prospect of adding sound to movies, **“Who the hell wants to hear actors talk?”**

Changing Minds

David Sarnoff employed by Marconi Wireless Telegraph Company of America, urged the management to invest in radio in the 1920’s – he got the following memo:

“The wireless music box has no imaginable commercial value. Who would pay for a message sent to nobody in particular?”

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A&E
ALL NEWS
Animal Planet
BBC AMERICA
BET
Bloomberg TELEVISION
Bravo
CARTOON NETWORK
Church Channel
CMT
CNBC
CNN
CNNfn
Headline NEWS
CNN INTERNATIONAL
CNN Sports Illustrated
COMEDY CENTRAL
COURT TV
C-SPAN
C-SPAN2
DAYSTAR
Discovery
Discovery Health
E!
ESPN
ESPN 2
ESPN Classic
ESPNEWS
food
FOX NEWS
FOX SPORTS NET
FX
Galavisión
GAME SHOW
Hallmark
HEALTH
THE HISTORY CHANNEL
HGTV
HSN
IFC
Lifetime
MSNBC
MTV
MTV2
NATIONAL GEOGRAPHIC CHANNEL
(oxygen)
PAX
QVC
SCI FI
Shop At Home NETWORK
ShopNBC
CHANNEL
TBN
TBS
TCM
techtv
TLC
TNT
Toon Disney
travel CHANNEL
Trio
TURNER SOUTH
TV LAND
USA NETWORK
Music First
WE
THE WEATHER CHANNEL
DISCOVERY CIVILIZATION CHANNEL
Discovery Kids
HOME & LEISURE
Discovery WINGS CHANNEL
BOOMERANG
THE Biography CHANNEL
WGN
THE WORD
Music Choice
31 audio channels
SCIENCE
diy
H INTERNATIONAL
PBS kidschannel
SN
classic
Music Choice
5 additional audio channels
HBO
starz SUPER PAK
SHOWTIME UNLIMITED
cinemax

Changing Minds

Story of AT&T or “Ma Bell”

Science faculty who have advanced pedagogical content knowledge

Andy Karplus

Kevin Ahern

Leslie Blair

Research Scientist
first attempt at student-centered teaching

Andy Karplus

Expose the students to skills needed to effectively read and analyze professional research in biophysics.

He wanted to develop the capabilities for being critical consumers of the literature and for selecting research that interested them and that they could grow from as a result of their own efforts.

Lecture: The bigger the better
You want a "concert experience"

Leslie Blair

At 500 you can produce a wave across the lecture hall. The idea is that if you are on campus there should be a distinctly campus flavor associated with educational experience.

Increasingly, students have a choice about where they get their education. If they choose to come to the OSU campus, what do they get there that they would not get anywhere else?

Sharing a passion for biochemistry
Revealing how life works!

Kevin Ahern

He has made video records of over 300 lectures all of which are **free** on YouTube. He has received messages from students around the country and the world describing how they have used his lectures to increase their knowledge.

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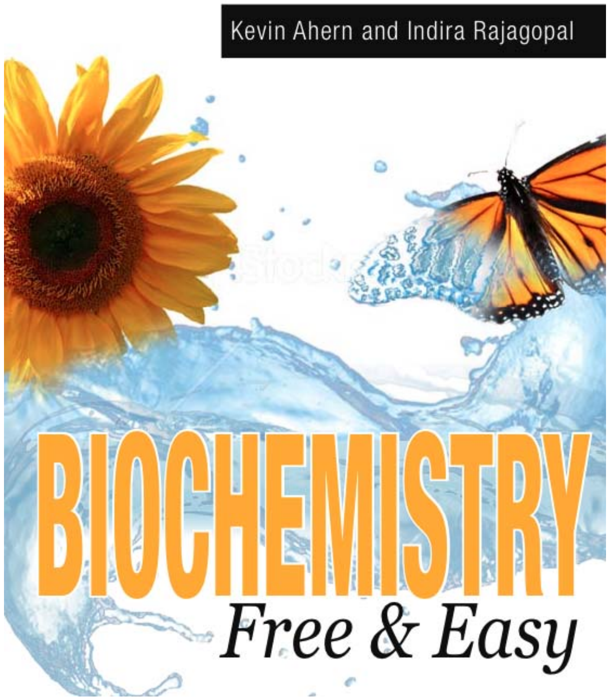
Written an iBook available free at the Mac App Store
Biochemistry Free & Easy
by Kevin Ahern and Indira Rajagopal

Kevin Ahern



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OSU Open Courseware Learning Module Program

- Learning modules developed from existing online course inventory
- Focused on individual learning objectives
- Available as foundation for additional online course development
- Available for K12 school curriculum enhancement
- Opportunity to enhance International Educational programs
- OSU's approach to Open Courseware

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Eight Implications

1. The shear variety of content presentations, courses, and programs will force examination of standard, on campus science learning environments.
2. We will find new ways for collecting data for advising and tracking our students towards university-worthy outcomes in science that have been vetted with faculty, students, families, business leaders, and donors.
3. As institutions compete for students in a larger market place, there will be greater emphasis on the value of inquiry into science teaching practices.

Eight Implications

4. Science instruction will become the responsibility of a team made up of content experts, often from across STEM disciplines, and electronic media and instructional design experts.
5. An ideal for John Dewey was that education provide ways of bringing people together. By more closely connecting online and on-campus experiences, this ideal may be achieved at scales never before imagined.
6. There will be greater emphasis in professional and scholarly societies on how to bring the meaning of new research results to students and the public through newly created physical and electron venues.

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Eight Implications

7. Collaborations across institutions will extend the reach of educational ideas and will offer opportunities to learn more about learning in science and innovative delivery of content.
8. STEM disciplinary practices provide instructional scaffolds for structuring student talk developing intellectual capacity for the use of evidence (in science) and making justifications and generalizations (in mathematics).

Ambitious Teaching

- Creating a more rigorous vocabulary for teacher moves, educational environments, and students learning
- Describing teacher actions and student responses that constitute learning trajectories
- Skills for eliciting, selecting, and ordering student ideas (student thinking) for the purpose of advancing the central content of the course
- Skills for managing presentation of content and student thinking with an eye on the horizon of future understandings

Changing Minds

- Western Union memo of 1876, “This *telephone* has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us.”