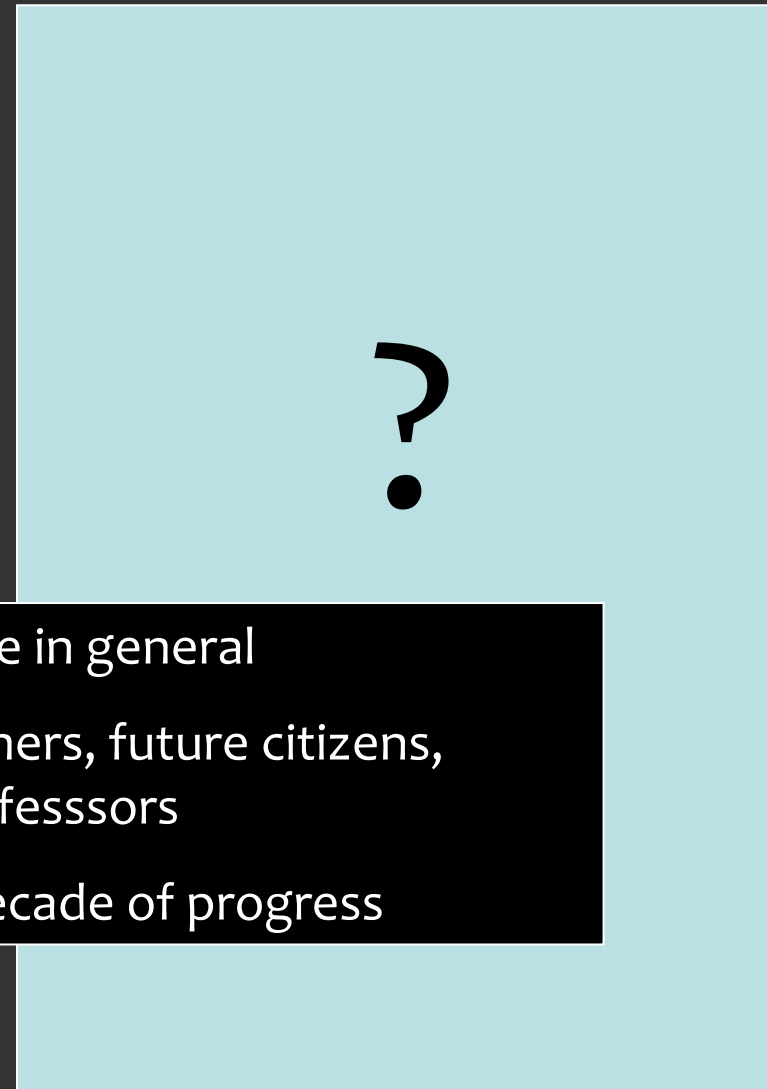




A vision for the next ten years

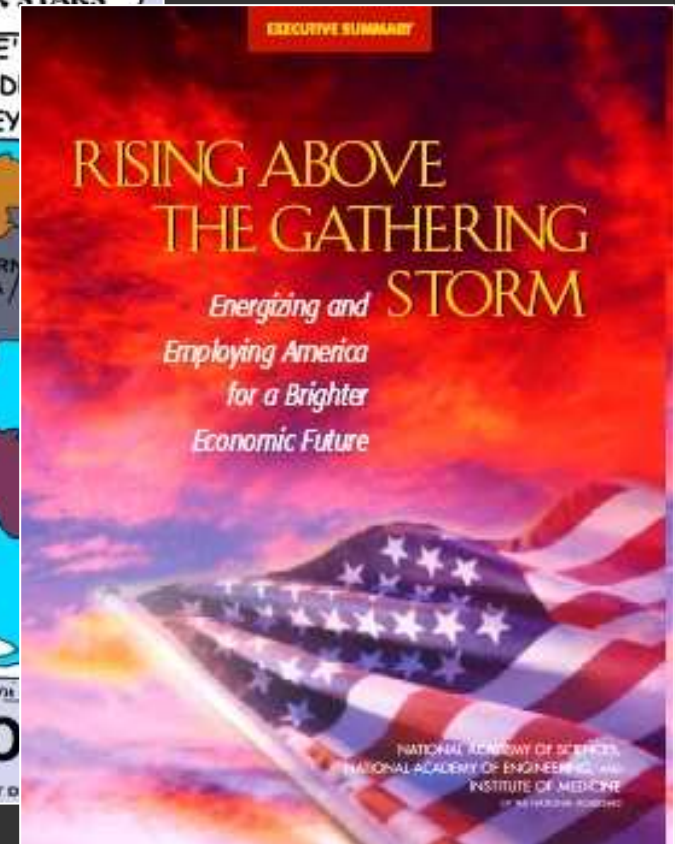
Felicia Keesing
Bard College



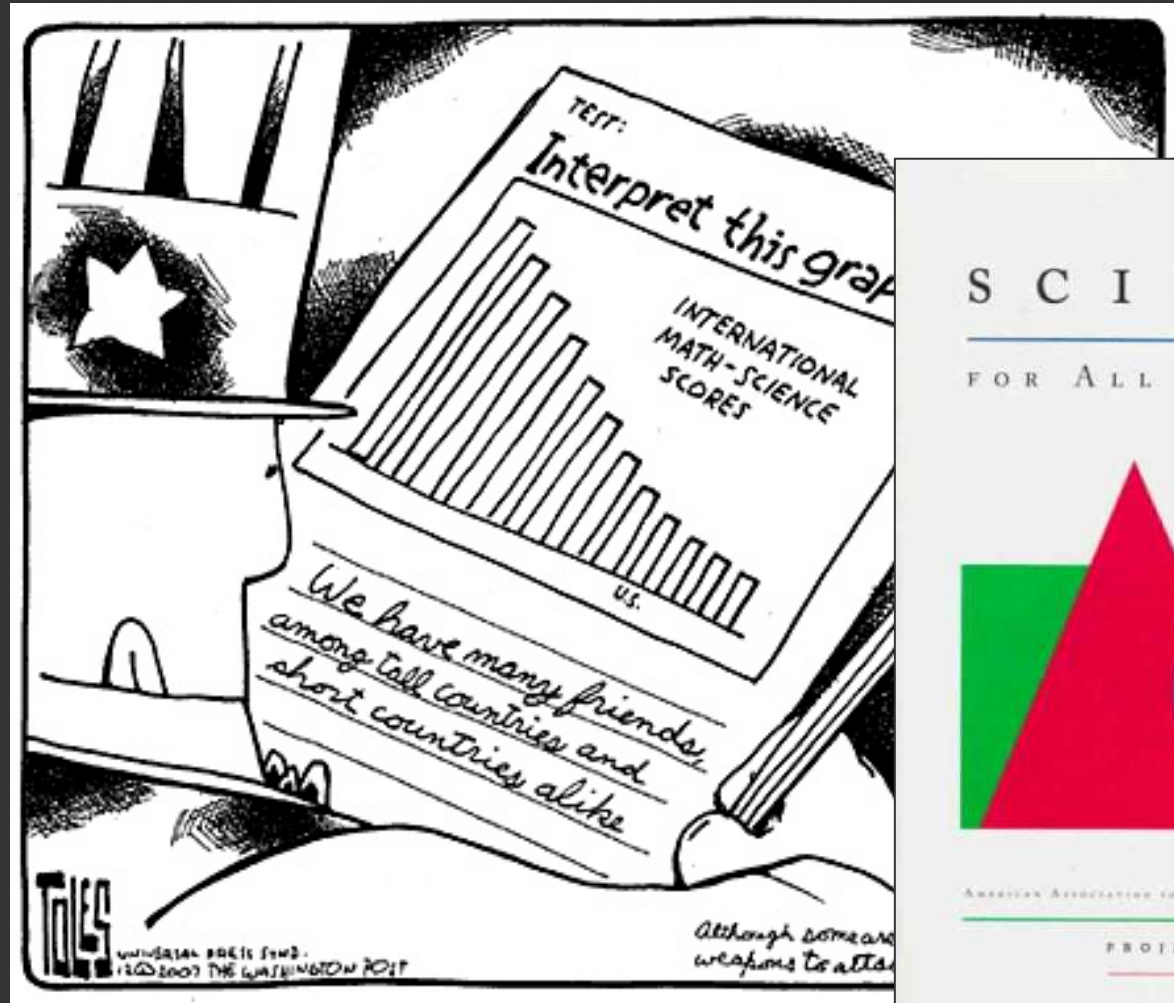
Why reform science education?



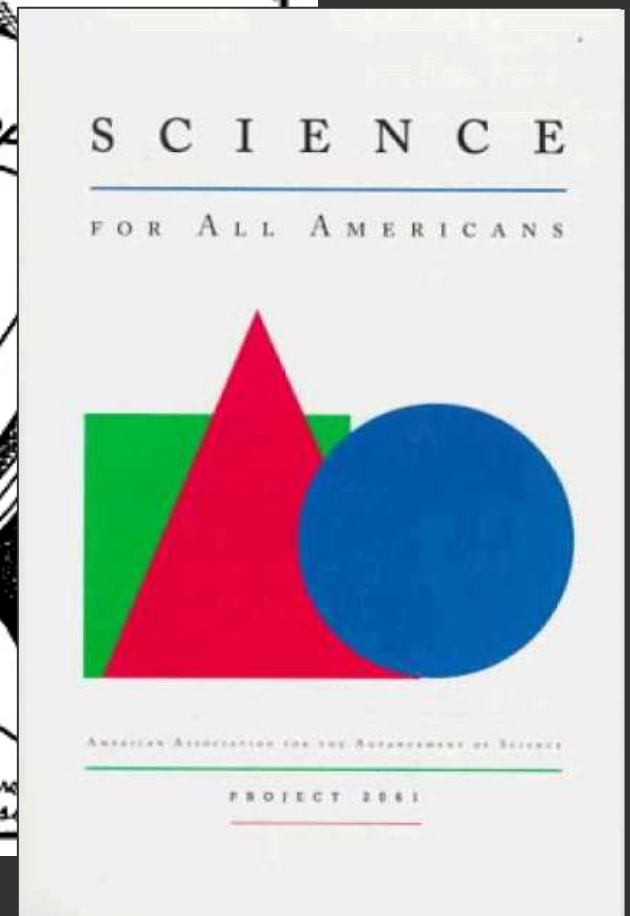
2007



Why reform science education?

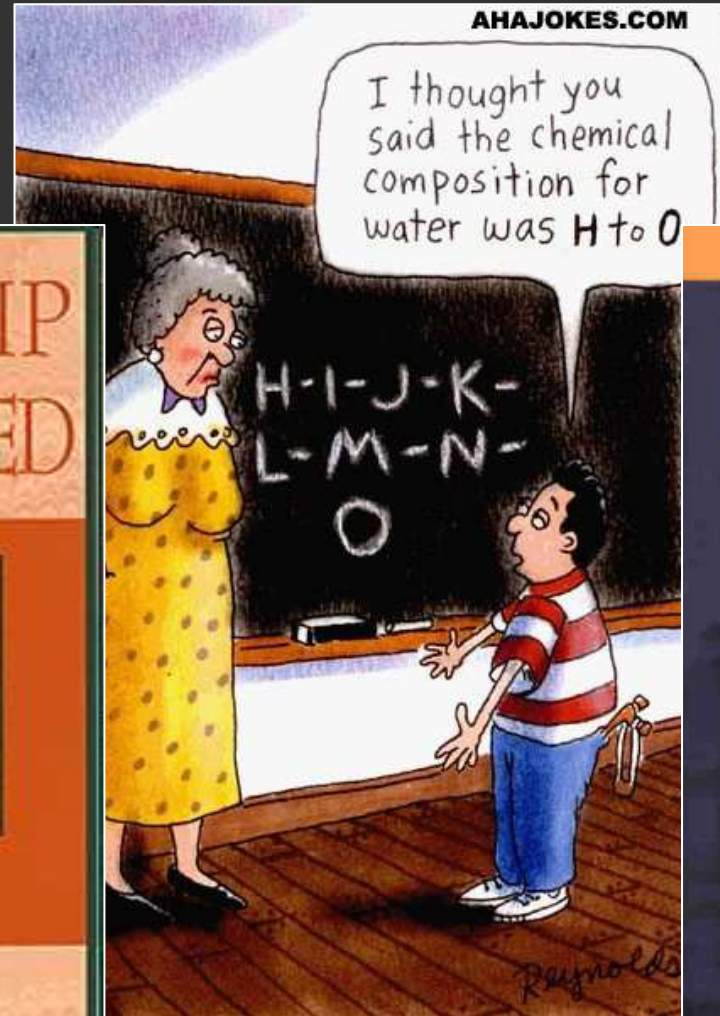
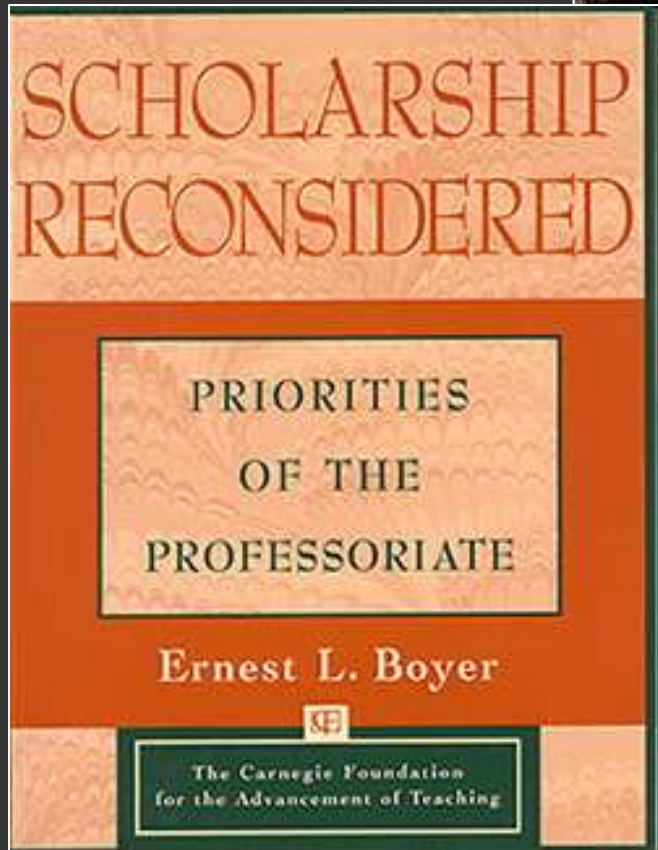


1989

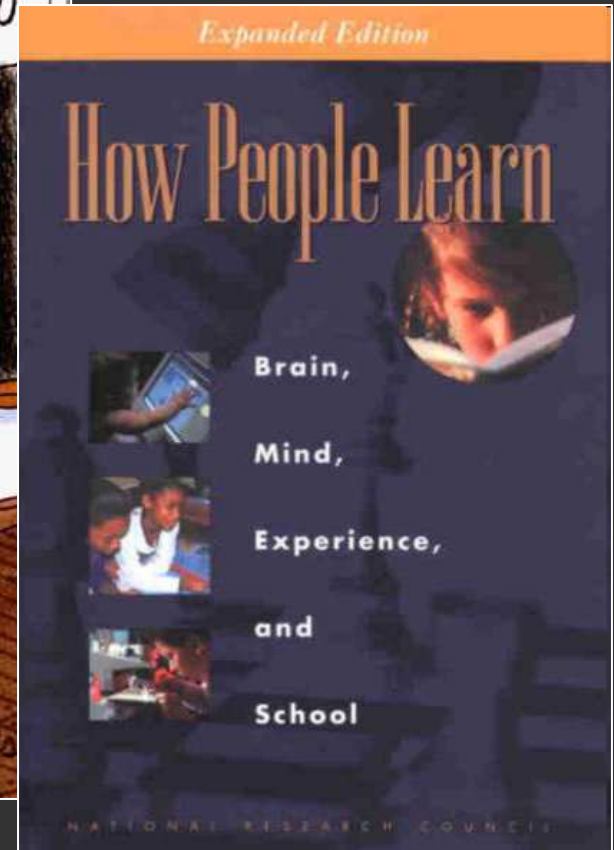


Why reform science education?

1997



1999



Why reform science education?

Workforce quantity & quality

Science literacy

Professional excellence

What we know

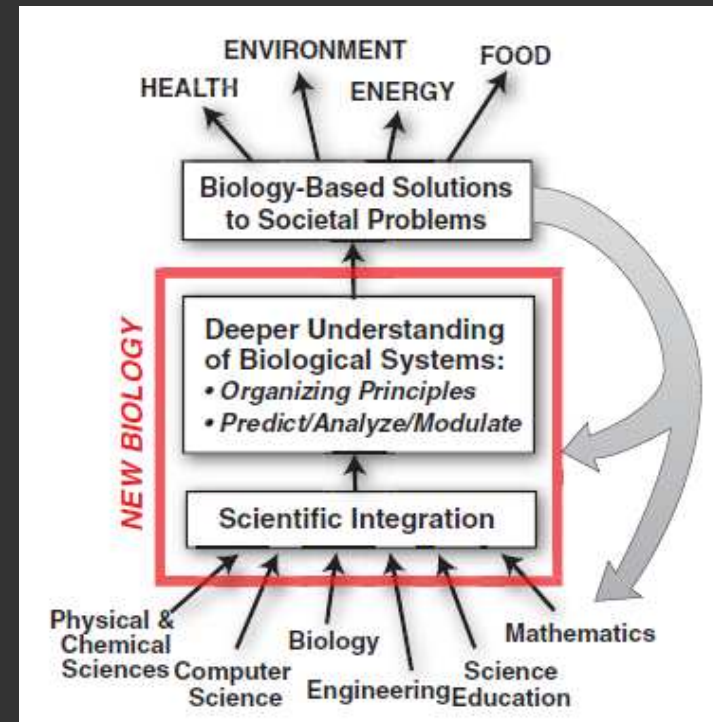
Workforce preparedness

- Future of fields: multidisciplinary, computational, systems-oriented, collaborative, applied(?)

A NEW BIOLOGY FOR THE 21ST CENTURY



NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES



What we know

Workforce preparedness

- Future of fields: multidisciplinary, computational, systems-oriented, collaborative, applied(?)
- Quality
 - Core concepts and competencies

What we know

Workforce preparedness

Framework for Science Education Standards



August 2010

Four concepts from each field

- Generating and evaluating scientific evidence
- Understanding development of scientific knowledge
- Participating in scientific practices

What we know

Workforce preparedness

- Future of fields: multidisciplinary, computational, systems-oriented, collaborative, applied(?)
- Quality
 - Core concepts and competencies
 - Disciplinary integration (seminars, research, intro)

THIS IS AN INTERDISCIPLINARY PROGRAM
IN WHICH PHYSICS STUDENTS TRY TO HIT
PSYCHOLOGY STUDENTS WITH PENDULUMS.



MY PROFESSORS HAD AN ONGOING COMPETITION
TO GET THE WEIRDEST THING TAKEN SERIOUSLY
UNDER THE LABEL "INTERDISCIPLINARY PROGRAM."

What we know

Workforce preparedness

- Future of fields: multidisciplinary, computational, systems-oriented, collaborative, applied(?)
- Quality
 - Core concepts and competencies
 - Disciplinary integration (seminars, research, intro)
 - Collaboration
 - Diversity
- Quantity
 - Introductory courses (better)
 - Hands-on research experiences (more & better)

What we know

Science literacy

- Global problems require informed citizenry



CHINA'S DISPUTES IN ASIA BUTTRESS INFLUENCE OF U.S.
 COUNTERBALANCING FORCE

Beijing's Neighbors See Need for Military Ally and Instability

By GREGORY HEARD

BEIJING — The rise of the United States and the United States' military power in Asia has long been a source of concern for the United States' neighbors. But now, as the United States' military power in Asia has long been a source of concern for the United States' neighbors, the United States' military power in Asia has long been a source of concern for the United States' neighbors.



Violence Amid a Song in Mid-east Peace Talks
 In the UN City of Jerusalem, the performance of a song that started after an Israeli guard killed a Palestinian, has become an anthem for the West Bank resistance and has become a symbol of the struggle for peace.

New Treatments Are Challenging Mammogram's Need, Study Says

By GINA KOLATA

NEW YORK — The United States' mammogram industry is being challenged by new treatments, according to a study published in the journal *Journal of the American Medical Association*. The study found that new treatments, such as targeted therapy and immunotherapy, are becoming more effective in treating breast cancer. This has led to a decline in the number of mammograms performed, as patients are now more likely to opt for these newer treatments. The study also found that these new treatments are often more expensive than mammograms, which could be a barrier for some patients.

Angry Voters Shout 'Recall' At City Halls

By MICHAEL LEWIS

THE DISSENTERS' movement is spreading across the United States, with voters demanding the recall of elected officials. This movement is gaining momentum as voters become increasingly dissatisfied with the performance of their elected representatives. In several states, voters have successfully recalled their representatives, leading to new elections. This trend is seen as a sign of growing public anger and a desire for change in government.

G.O.P. A To Take Pushes

By MICHAEL LEWIS

The Republican Party is pushing for a new approach to dealing with the economic crisis. The party's new strategy focuses on reducing government spending and promoting private industry. This approach is seen as a way to stimulate economic growth and create jobs. However, critics argue that this strategy could lead to further cuts in social services and infrastructure, which could have long-term negative effects on the economy.



On the Ground on Health Care
 A gathering in Virginia, President Obama's health care reform, which aims to take off the nation's financial and economic burden and preparing for the future. (Page A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19, A20, A21, A22, A23, A24, A25, A26, A27, A28, A29, A30, A31, A32, A33, A34, A35, A36, A37, A38, A39, A40, A41, A42, A43, A44, A45, A46, A47, A48, A49, A50, A51, A52, A53, A54, A55, A56, A57, A58, A59, A60, A61, A62, A63, A64, A65, A66, A67, A68, A69, A70, A71, A72, A73, A74, A75, A76, A77, A78, A79, A80, A81, A82, A83, A84, A85, A86, A87, A88, A89, A90, A91, A92, A93, A94, A95, A96, A97, A98, A99, A100, A101, A102, A103, A104, A105, A106, A107, A108, A109, A110, A111, A112, A113, A114, A115, A116, A117, A118, A119, A120, A121, A122, A123, A124, A125, A126, A127, A128, A129, A130, A131, A132, A133, A134, A135, A136, A137, A138, A139, A140, A141, A142, A143, A144, A145, A146, A147, A148, A149, A150, A151, A152, A153, A154, A155, A156, A157, A158, A159, A160, A161, A162, A163, A164, A165, A166, A167, A168, A169, A170, A171, A172, A173, A174, A175, A176, A177, A178, A179, A180, A181, A182, A183, 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What we know

Science literacy

- Global problems require informed citizenry
 - ?
- Number of courses

Table 3: Percent of Adults Qualified as Civic Scientifically Literate in 33 Countries, 2005.

	CSL
Sweden	35%
United States	28
Netherlands	24
Norway	22
Finland	22
Denmark	22
Bulgaria	19
Iceland	18
Belgium	18
Germany	18
France	17
Switzerland	17
Czech Republic	17
Luxembourg	17
Hungary	15
Great Britain	14

J. Miller 2006

Available at <http://www.arcsfoundation.org/pittsburgh/JMiller.pdf>

What we know

Science literacy

- Global problems require informed citizenry
 - ?
- Number of courses
- Transfer
 - Core concepts and competencies (Miller)
- Undergraduate teaching has high leverage
 - Trains future K-12 teachers
 - Affects adult science literacy
 - Models effective pedagogy for future professors

What we know

Professional excellence

- Reward structures are a barrier
- Faculty training is a barrier
- Education is changing

Free online biology courses

Massachusetts Institute of Technology (mit.edu)

[Introductory Biology Course](#)

[Molecular Biology Course](#)

[Cell Biology Course](#)

University of Utah (utah.edu)

[Principles of Biology Course](#)

[Human Physiology Course](#)

University of Massachusetts, Boston (umb.edu)

[General Biology I Course](#)

[General Biology II Course](#)

University of California, Berkeley (berkeley.edu)

[General Biology Course](#)

[General Biology Laboratory](#)

[General Biology Lecture](#)

Carnegie Mellon University (cmu.edu)

[Modern Biology Course](#)

University of Leeds (leeds.ac.uk)

[Human Biology Course](#)

What we know

Professional excellence

- Reward structures are a barrier
- Faculty training is a barrier
- Education is changing
- Evidence works(?)

How do we effect change?

- Accumulate evidence of what works
 - E.g. how to teach collaboration, which core concepts, how to train multidisciplinary scientists
 - And how to use it
- And why
 - Value of science literacy to policy
 - Effect of pedagogical practices on student choices

How do we effect change?

- Improve pedagogy (where's the leverage?)
 - (Re)train faculty (e.g. Wisconsin summer institute)
 - Provide resources



Case Studies in Science

State University of New York at Buffalo

- An “easy” way to start improving pedagogy?
- Many resources available
- Could case studies be a “gateway drug”?

You Are Not the Mother of Your Children

by

Stephen R. Cronin
Department of Biology and Chemistry
Ave Maria University, Ave Maria, FL



How do we effect change?

- Improve pedagogy (where's the leverage?)
 - (Re)train faculty (e.g. Wisconsin summer institute)
 - Provide resources
 - BEN, HHMI “Cool Science”, Science Education Alliance, ..., “Boogle”
 - Technology – clickers, sophisticated graders, vodcasts
 - Communities of teaching and learning
 - Provide evidence – syntheses of results of what works
 - NRC and WCER workshops 2008
 - Motivate faculty and administration
 - Provide evidence
 - Provide resources

Themes of Science 2020

- Keep doing what we have been doing
 - Improving pedagogy
 - Improving curricula
 - Improving training
- Use leverage
 - Introductory undergraduate classes
 - Case studies
 - Influential faculty members, dept. chairs
 - Strategic planning committees

Themes of Science 2020

- Focus on core concepts & competencies
 - For future scientists & engineers
 - For future citizens
 - For future faculty
- (Re)new focus on science literacy
 - Problem-oriented for concepts?
 - Approach-oriented for competencies?
 - Modeling, experiments, comparisons
 - Increase required courses for non-majors?

What is Science 2020?

- Focus on collection, evaluation, synthesis and dissemination of evidence

Assessment

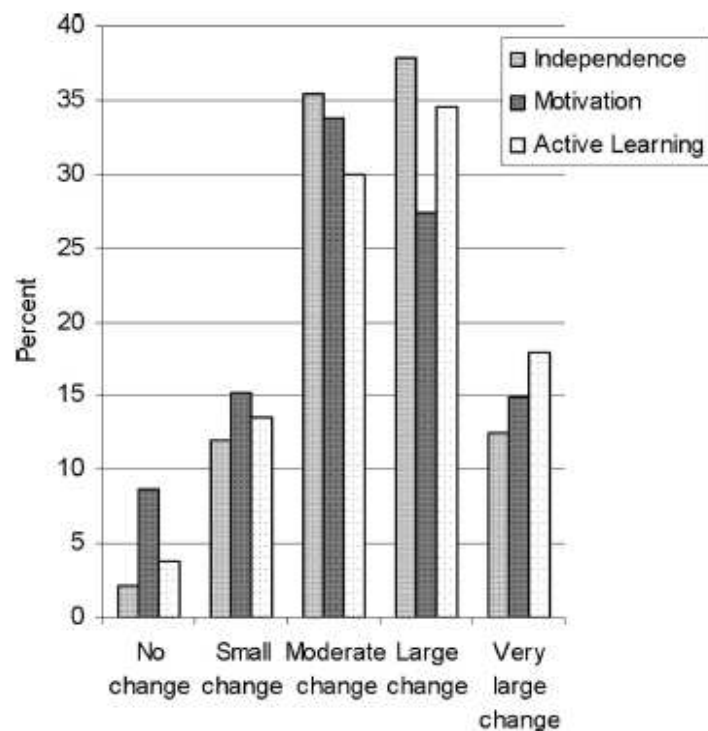


Figure 3. The bar chart shows the percentage of respondents who reported their behavior in courses in their field after the completion of a summer undergraduate research experience. The three items were as follows: "I feel that I have become better able to think independently and formulate my own ideas"; "I feel that I have become more intrinsically motivated to learn"; and "I feel that I have become a more active learner."

Lopatto 2007

CBE Life Sci Educ 6(4): 297-306

Table 6. Learning gain items on which members of the under-represented group showed significantly higher mean gains than the comparison group

Item	Underrepresented group ^a	Comparison group ^b
Ability to integrate theory and practice	3.84 ± 0.98	3.69 ± 0.99
Understanding that scientific assertions require supporting evidence ^c	3.93 ± 1.1	3.57 ± 1.2
Ability to analyze data	3.91 ± 1.0	3.69 ± 1.0
Understanding science ^c	3.84 ± 0.99	3.48 ± 1.1
Learning ethical conduct ^c	3.49 ± 1.2	2.99 ± 1.3
Learning lab techniques	4.13 ± 1.1	3.92 ± 1.2
Ability to read primary literature	3.78 ± 1.0	3.48 ± 1.2
Skill in how to give an effective oral presentation	3.70 ± 1.2	3.31 ± 1.3
Skill in science writing	3.48 ± 1.1	3.05 ± 1.2
Self-confidence	3.68 ± 1.1	3.46 ± 1.1
Understanding of how scientists think ^c	3.71 ± 0.98	3.50 ± 1.0
Learning to work independently	3.99 ± 1.0	3.74 ± 1.1
Becoming part of a learning community	3.95 ± 1.0	3.67 ± 1.1

Lopatto 2007

CBE Life Sci Educ 6(4): 297-306



Pergamon

Learning and Instruction 13 (2003) 533–568

Learning and Instruction

www.elsevier.com/locate/learninstruc

Abstract

This meta-analysis has two aims: (a) to address the main effects of problem based learning on two categories of outcomes: knowledge and skills; and (b) to address potential moderators of the effect of problem based learning. We selected 43 articles that met the criteria for inclusion: empirical studies on problem based learning in tertiary education conducted in real-life classrooms. The review reveals that there is a robust positive effect from PBL on the skills of students. This is shown by the vote count, as well as by the combined effect size. Also no single study reported negative effects. A tendency to negative results is discerned when considering the effect of PBL on the knowledge of students. The combined effect size is significantly negative. However, this result is strongly influenced by two studies and the vote count does not reach a significant level. It is concluded that the combined effect size for the effect on knowledge is non-robust. As possible moderators of PBL effects, methodological factors, expertise-level of students, retention period and type of assessment method were investigated. This moderator analysis shows that both for knowledge- and skills-related outcomes the expertise-level of the student is associated with the variation in effect sizes. Nevertheless, the results for skills give a consistent positive picture. For knowledge-related outcomes the results suggest that the differences encountered in the first and the second year disappear later on. A last remarkable finding related to the retention period is that students in PBL gained slightly less knowledge, but remember more of the acquired knowledge.



Keesing
Case Studies Conference 2010



TRANSFORMING
SCIENCE
EDUCATION
FOR
EVERYONE

The central graphic is a vertical rectangle with a light blue top section. Below this is the "SCIENCE 2020" logo. The bottom half of the rectangle is split: the left side shows a molecular model with blue and yellow spheres, and the right side shows a green circuit board. The text "TRANSFORMING SCIENCE EDUCATION FOR EVERYONE" is written in white on a dark grey background in the bottom right corner.