IUBS

International Union of Biological Sciences

promoting biological sciences for a better life

International Union of Biological Sciences
Commission for Biological Education

Undergraduate Research: Engagement, Mentoring, and Reform

John R. Jungck

President, IUBS Commission for Biology Education

Vice President, IUBS

Editor, Biology International

Mead Chair of the Sciences

Professor of Biology

Beloit College

Personal History of Research & Mentoring Students: A Growing Legacy

2011	Cell Division Tessellations & Image Analysis; Food Webs
2004	Phylogenetic Analysis & Bioinformatics
2003	Lindenmayer Systems & Fractal Geometry
2002	Biological ESTEEM Project
1999	Knot Theory & DNA
1986	Initiated the BioQUEST Curriculum Consortium
1985	Fulbright Scholar Thailand
1976	Interval Graphs; Voronoi Tessellations
1975	Genetic Codes as Codes
1974	Drug Design for Diseases of the Developing World
1968	Origins of Life: Synthesis of Nucleic Acids & Nonrandomness
1968	NASA Exobiology (Astrobiology) – Sounding Rockets; Moon Rocks
1966	Molecular Sequence Analysis (1st year of college teaching)
1966	Chloroplast Genes: Colinearity of Cytoplasmic Genes and Proteins
1964	Building an Automated Protein Sequencer
1960	Bioremediation: Microbial Clean-up on Industrial Accidents

Where my students have published

Bulletin of Mathematical Modeling

Mathematical Modelling of Natural Phenomena

BioSystems

Briefings in Bioinformatics

BIOMAT

Journal of Heredity

Bioinformatics (submitted)

Bioscence

Journal of Young Investigators

CBE Life Science Education

BioQUEST Library

The Biological ESTEEM Project

BEDROCK Problem Spaces

MAA Digital Classroom Resources

NIMBioS

National Institute for Mathematical and Biological Synthesis

Society for Mathematical Biology

B.E.E.R.

Biomathematics and Ecology: Education and Research

CUR

Council on Undergraduate Research

Council for Undergraduate Research

Pew Midstates Mathematics and Science Consortium

National Academies of Science

Where my students have recently presented:

Where are some of my recent students who have gone on to do graduate work in bioinformatics, biostatistics, computational biology, and mathematical biology?

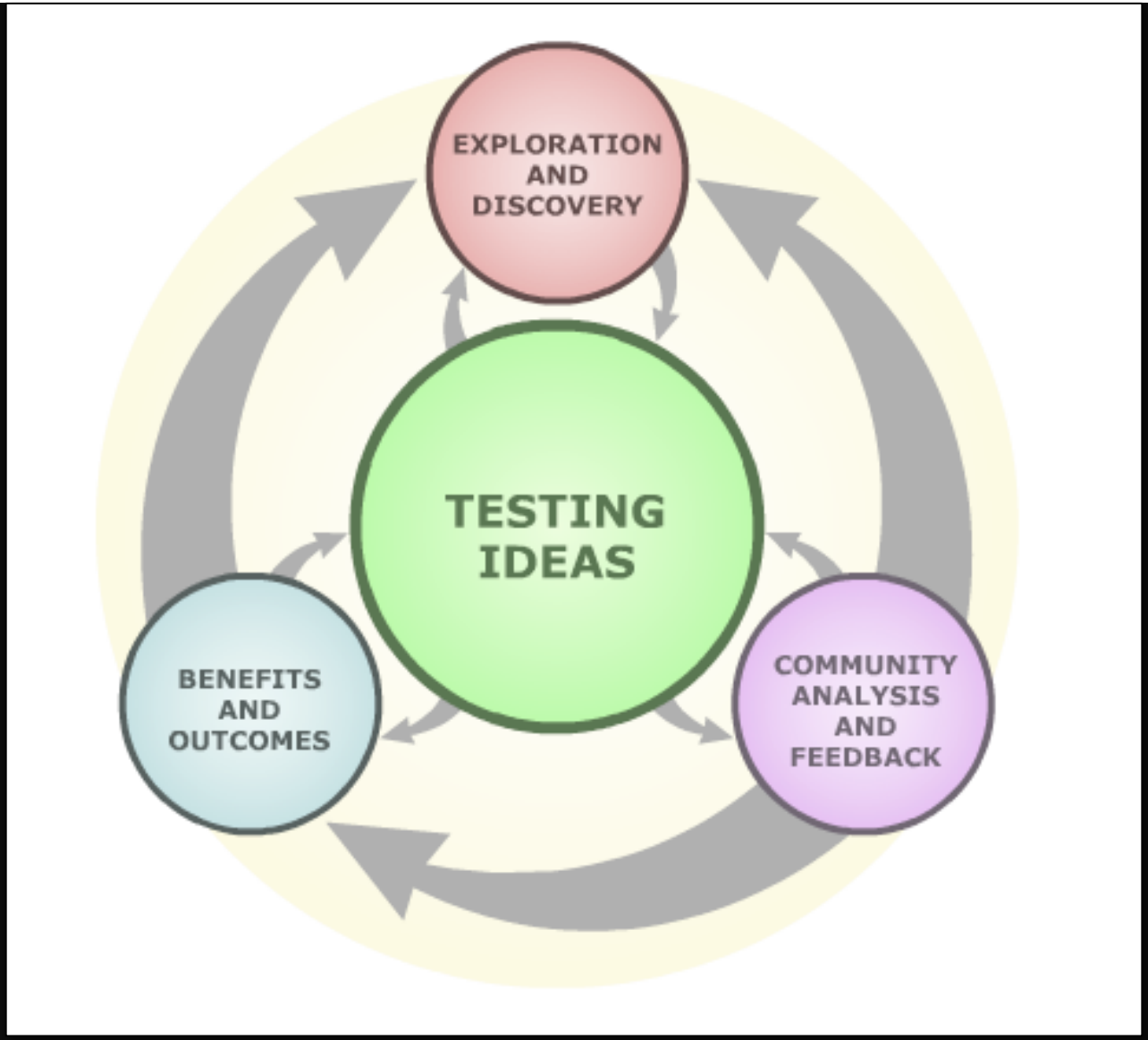
Anna Decker	University of California Berkeley
Katie Geist	Washington University
Ariella Gladstein	University of Arizona
Vanja Klepac-Ceraj	Harvard University
Winnie Kretschmar	Cambridge University
Han Lai	Carnegie Melon University
Joe Reitstetter	University of Washington
Adrian Smith	Arizona State University
Marcin Wiczla	University of Chicago

Undergraduate Research:

Engagement,
Mentoring,
and
Reform

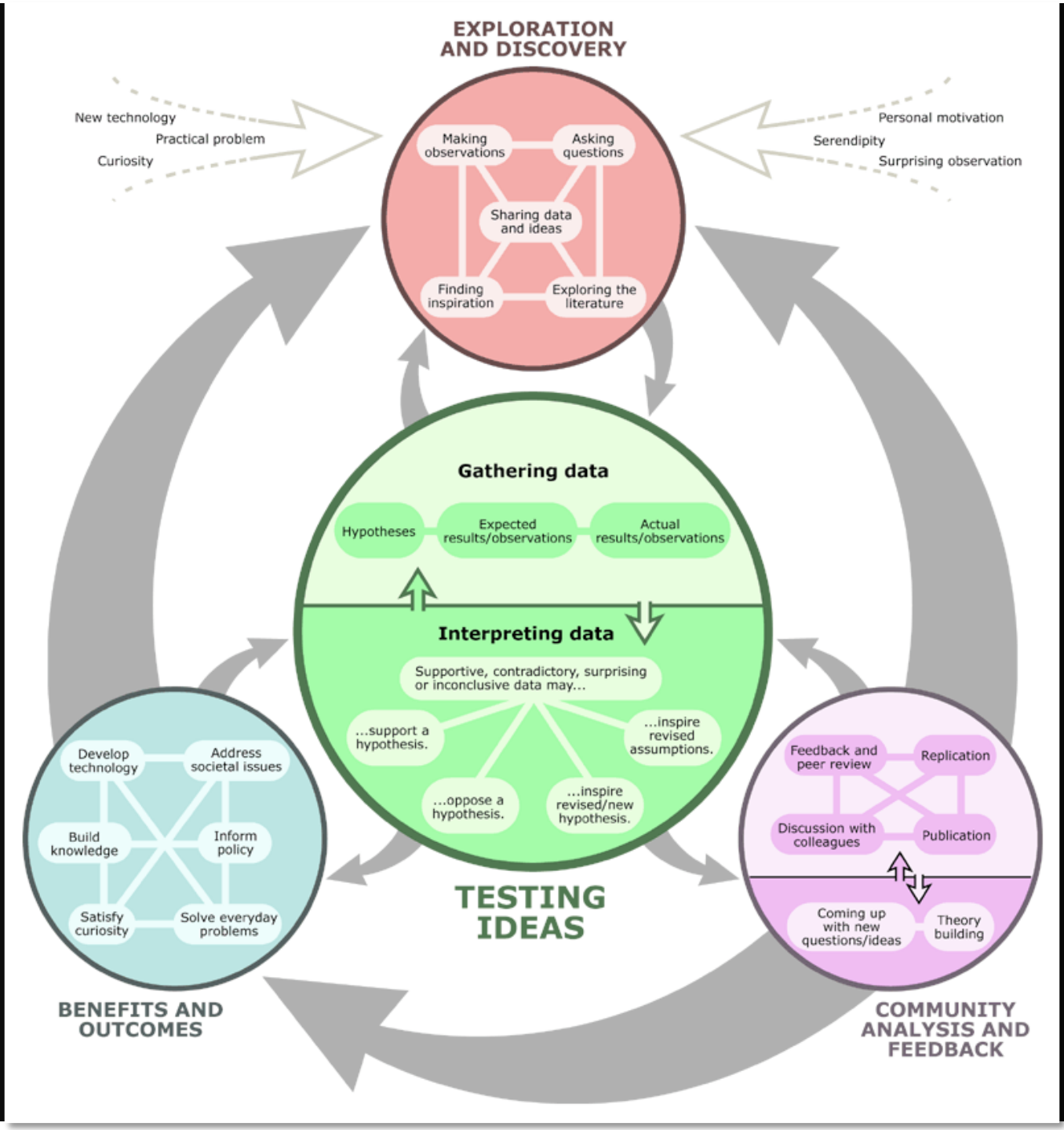
Sharing with the already committed:

I don't presume that I'm saying anything that either you aren't currently doing or haven't thought about; but what I can share is a perspective on how we tell our story to others about what and why we do it – and – provide some of the published literature to back up the practices that we are engaged in



Understanding Science
how science *really* works

http://undsci.berkeley.edu/


EXPLORATION AND DISCOVERY
New technology
Practical problem
Curiosity
Personal motivation
Serendipity
Surprising observation
Making observations
Asking questions
Sharing data and ideas
Finding inspiration
Exploring the literature
Gathering data
Hypotheses
Expected results/observations
Actual results/observations
Interpreting data
Supportive, contradictory, surprising or inconclusive data may...
...support a hypothesis.
...inspire revised assumptions.
...oppose a hypothesis.
...inspire revised/new hypothesis.
TESTING IDEAS
Develop technology
Address societal issues
Build knowledge
Inform policy
Satisfy curiosity
Solve everyday problems
BENEFITS AND OUTCOMES
Feedback and peer review
Replication
Discussion with colleagues
Publication
Coming up with new questions/ideas
Theory building
COMMUNITY ANALYSIS AND FEEDBACK

THE BELOIT BIOLOGIST

Volume 29 2010

Beloit Biologist

32 years

The Beloit Biologist is a journal published annually by the Beloit College Biology Department that publishes critical reviews and primary research manuscripts written by Beloit College students. Critical reviews examine one or more hypotheses using data available in the primary literature. Primary research manuscripts present and discuss research results for the first time. Manuscripts submitted to The Beloit Biologist are written for a general biological audience. Students writing manuscripts for submission to the journal participate in the Biology Department's capstone course, BIOL 387.

In this course,

students develop a question and one or more testable hypotheses about a biological topic,

gather and evaluate information from the published literature that pertains to the testable hypotheses,

write a critical review or primary research manuscript on the biological topic,

submit a manuscript to The Beloit Biologist,

review manuscripts submitted by other students to The Beloit Biologist,

revise a manuscript in response to constructive criticism from the instructor, associate editor, and peer reviewers,

create and present a poster at the Biology Poster Session, and

create a CV or resume and cover letter for use in applying for jobs and/or graduate school.

The Beloit Biologist is published in May and is distributed at the Biology Department Commencement Breakfast.

Changing views

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- Personal web pages with easy downloads
- P2P
- BioQUEST resource center

Visit: http://www.edu-cyberpg.com/Internet/copyleft.html

Writers, Readers, & Knowledge Makers

We want you

1) **as writers, to feel the pressure of a reader's presence**
2) **as readers, to discover a vocabulary with which to consider writing**
3) **as knowledge makers, to view the social and incremental way that knowledge is constructed, one response at a time.**

--Tinberg, Howard. Peer Review and Teacher Commentary. TETYC, March 2004.

Technical Comments

- Grammar, Syntactical Felicity, Spelling
- Audience
- References
- Illustrations
- Format: Adherence to guidelines
- Are all elements present?
- What do you as a reader not understand or need further clarification?
- Concrete suggestions for improvement beyond the mechanics …

Note Well

- You will be evaluated in your undergraduate research not only by your papers and presentations, but the quality of your investment in your colleagues' work.
- Thus, peer reviewing is an essential and important part of this summer's work.
- Peer reviewing is an essential and important part of scientific community construction and the production of vetted, quality new knowledge.

Undergraduate Research Experiences:

Synergies between Scholarship and Teaching

By Tim Elgren, past president of the Council on Undergraduate Research and associate professor of chemistry, Hamilton College, and **Nancy Hensel,** executive officer of the Council on Undergraduate Research

For good reason, undergraduate student-faculty collaborative research opportunities are firmly embedded in the landscape of the New Academy. Undergraduate research and creative expression are now distinct categories of excellence in the *U.S. News & World Report* rankings. Collaborative research speaks to some of our most fundamental educational objectives by providing a personalized education, exemplifying engaged pedagogy, and promoting students' intellectual independence and maturation. Barrett Seaman's recent account of undergraduate residential life cites undergraduate research experiences as one of the ways that students make close personal connections with faculty mentors (2005).

These relationships are particularly important at a time when undergraduates are seemingly more disengaged in their education and rarely interact with faculty members outside of the classroom. These connections with faculty, across all academic disciplines and at a wide range of institutions, can be particularly meaningful to students deemed "at risk," including first-generation college students and minorities. For the past twenty-six years, the Council on Undergraduate Research has been a steady advocate and resource for institutions and faculty members seeking to implement research with undergraduates and create supportive environments in which these activities can flourish. Since 1989, Project Kaleidoscope has also brought together faculty and administrators to strengthen the learning and undergraduate research environments for mathematics and science.

Curricular and Institutional Transformation

We often cite the transformative effect research experiences can have on our undergraduate students, but the movement to provide more of these opportunities across all disciplines has led to significant transformations of curricula and institutions as well. Curricula that incorporate discovery-based and active learning have been designed to better prepare students for the independence required for a successful research experience (Karukstis and Elgren, forthcoming). Such curricular changes promote greater exposure to the primary literature; create opportunities to articulate and test hypotheses and intellectual models; and encourage students to contextualize and communicate objectives, approaches, analyses, and conclusions. These changes infuse research and research-like experiences into the curriculum.

Faculty members also stand to benefit from these curricular reforms. The curriculum is the purview of the faculty and should be a direct expression of what faculty value in education. It is also one of the ways that faculty gain some control over time, which many regularly cite as their primary limiting resource. Balancing a scholarly agenda with heavy teaching commitments easily consumes available time, but utilizing the curriculum to better prepare undergraduates for independent research serves them well and prepares them to contribute to faculty members' own scholarly work. Building synergy between these two activities has recently been referred to as an act of "enlightened self-interest" (Mills 2005).

Peer Review

CPR
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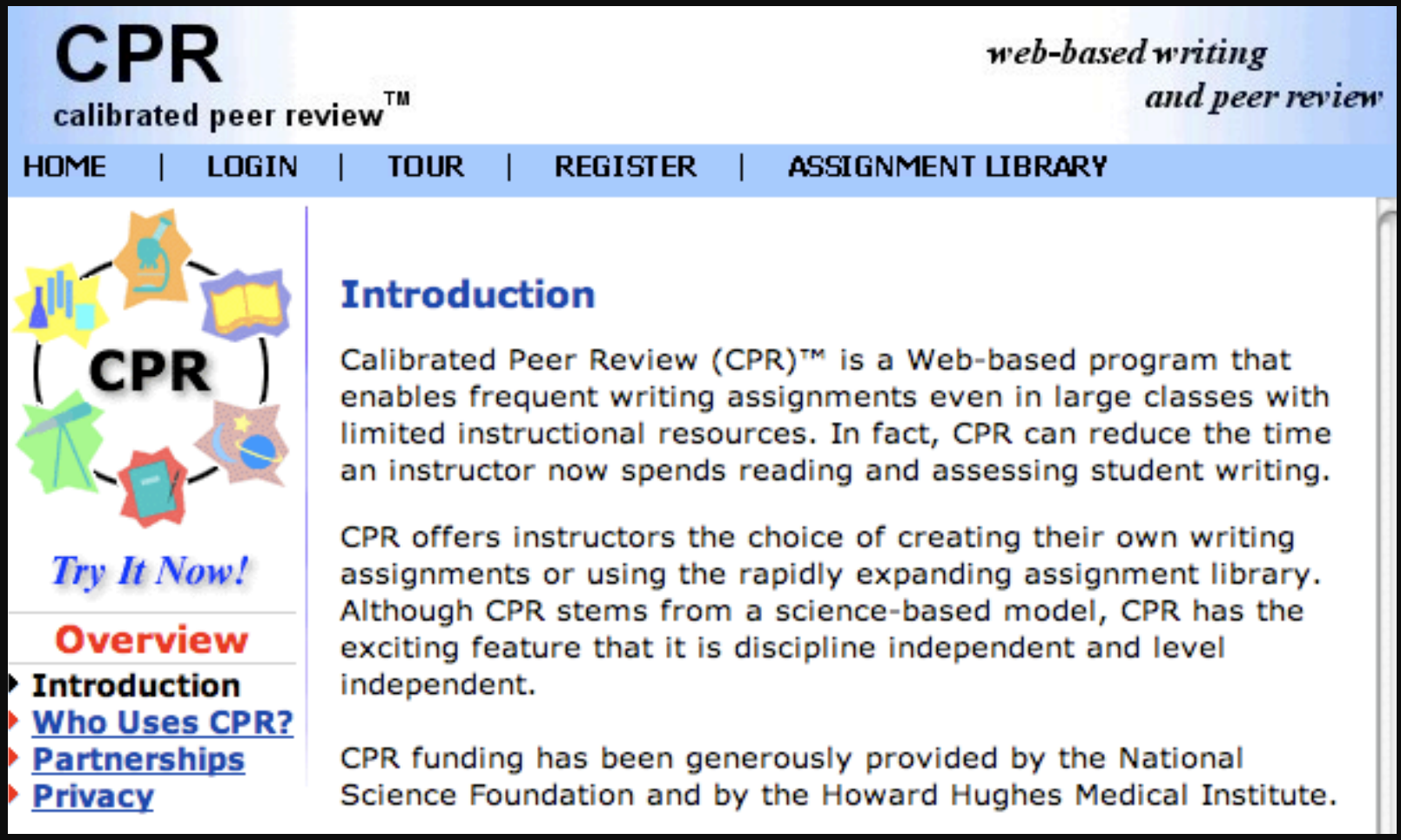
and peer review

Calibrated Peer Review™ Writing, Collaboration, and Critical Thinking

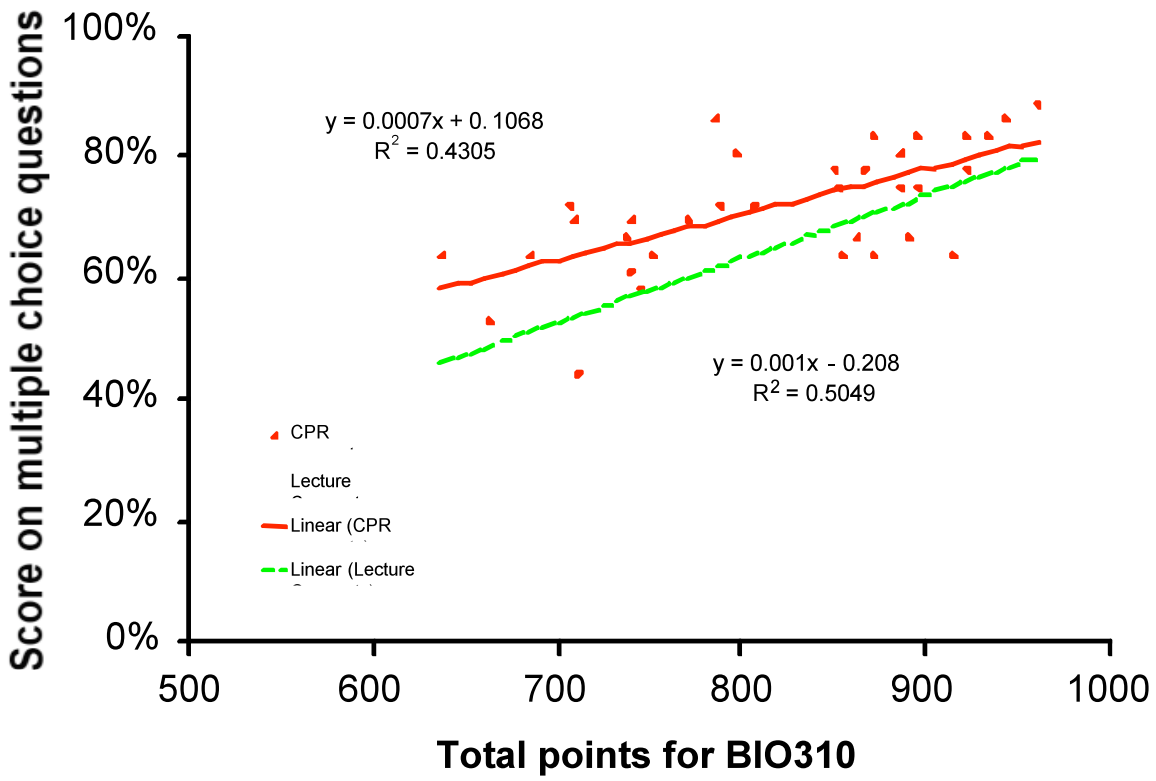
http://cpr.molsci.ucla.edu

Arlene A. Russell, UCLA

University of Maryland
November 13, 2003



Calibrated Peer Review



Mean multiple choice test scores were significantly better for topics taught using CPR compared with those taught using traditional instruction.

72 ± 2% versus 65 ± 2%, P < 0.001, Paired t-test.

Peer Review

- How would you define Peer Review?
- What are your expectations for Peer Review?
- When would YOU want peer review?
- What sort of responses would YOU appreciate?
- What feelings might YOU have about receiving responses to your work?

Peer Review Template

- http://www.middlesex.mass.edu/carnegie/MCCCG/MCCReviewGuidelines.htm
- Adapted from:
- ***Scholarship Assessed: Evaluation of the Professoriate*** by Charles Glassick, Mary Taylor Huber, and Gene Maeroff. San Francisco: Jossey-Bass. 1997.

Guidelines for Review

- **Author Name:**
- **Reviewer Name:**
- **Paper Title:**
- **Date:**
- **General Comments:**

- **Clear Goals:** Does scholar state basic purposes of his/her work clearly? Does the scholar define objectives that are realistic and achievable? Does the scholar identify important questions in the field?

- **Adequate Preparation:** Does the scholar show an understanding of existing scholarship in the field? Does the scholar bring the necessary skills to his or her work? Does the scholar bring together the resources necessary to move the project forward?

- **Appropriate Methods:** Does the scholar use methods appropriate to the goals? Does the scholar apply effectively the methods selected? Does the scholar modify procedures in response to changing circumstances?

- **Significant Results:** Does the scholar achieve the goals? Does the scholar's work add consequentially to the field? Does the scholar's work open additional areas for further explorations?

- **Effective Presentations:** Does the scholar use a suitable style and effective organization to present his or her work? Does the scholar use appropriate forums for communicating work to its intended audiences? Does the scholar present his or her message with clarity and integrity?

- **Reflective Critique:** Does the scholar critically evaluate his or her own work? Does the scholar bring an appropriate breadth of evidence to his or her critique? Does the scholar use evaluation to improve the quality of future work?

- ***Scholarship Assessed: Evaluation of the Professoriate*** by Charles Glassick, Mary Taylor Huber, and Gene Maeroff. San Francisco: Jossey-Bass. 1997.

JYI Journal of Young Investigators

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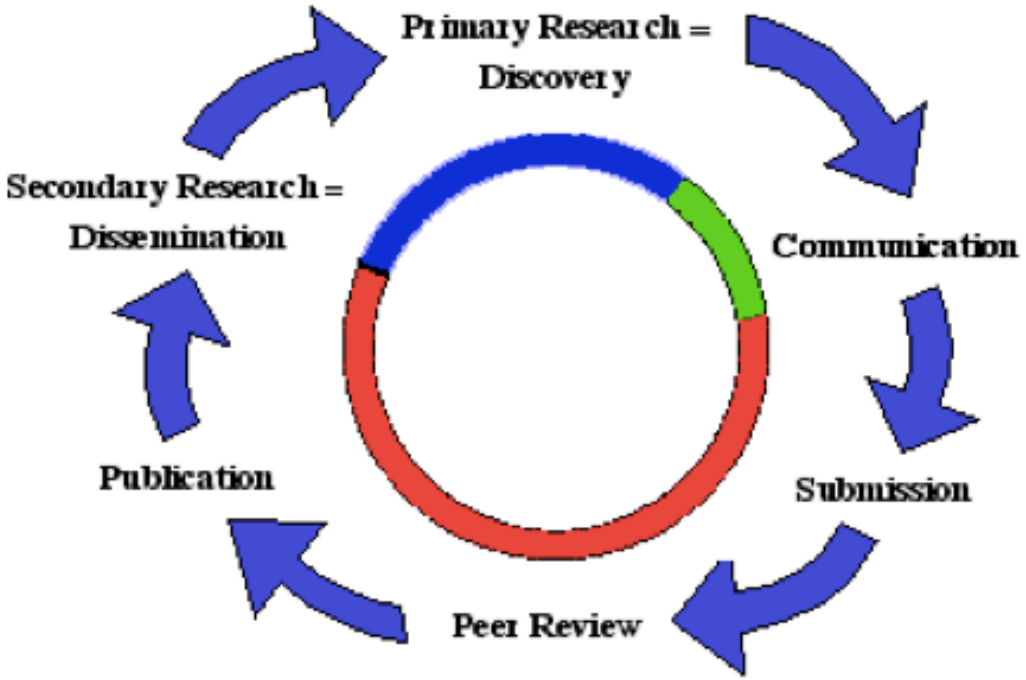
JYI

Journal of Young Investigators

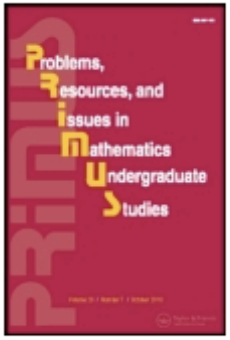
Professional Advisor Handbook

By: Nafisa Jadavji, Senior Research Editor
Last Modified: January 13, 2007

Information Life Cycle



American Journal of Undergraduate Research



PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies

Increasing to 8 issues in 2010

Published By: Taylor & Francis
Volume Number: 21
Frequency: 8 issues per year
Print ISSN: 1051-1970
Online ISSN: 1935-4053

Aims & Scope

PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies is a refereed journal devoted to dialogue and exchange of ideas among those interested in teaching undergraduate mathematics. This includes those who prepare students for college level mathematics, those who teach college level mathematics, and those who receive students who have been taught college level mathematics.

Each issue contains relevant and worthwhile material for those interested in collegiate mathematics education. While the primary interest is in first person descriptive and narrative articles about implemented teaching strategies and interesting mathematics, there is also opportunity for writing broad survey articles, formal studies of new teaching approaches, assessments of planned and in place strategies, and general discussion writing on teaching undergraduate mathematics.

Undergraduate Research: Mathematical Modeling of Mortgages

Youngna Choi & Steven Spero

pages 698-711

Volume 20, Issue 8, 2010

DOI:10.1080/10511970902840698
Available online:29 Oct 2010

The UMAP Journal

Publisher
COMAP, Inc.

Vol. 22, No. 4

Regularly run:
Modeling Contests

Table of Contents

Why should you publish or present your work?

- Professional obligation
- Way your findings make their way into practice and policy (classroom,industry, society)
- Improve visibility of yourself,department, university, company,government agency

About CUR
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visions & Governance
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Table of Contents | Prev | Next

The Importance and Value of Mentoring Undergraduates

Mentors play a significant role in providing intellectual stimulation for their student protégés. Through working together on a research project of mutual interest, students become colleagues with their mentors and other members of the research group. Sometimes these relationships last long after the student completes his or her degree and ultimately develop into strong professional interactions.

Students learn first-hand the nature of science or engineering. They apply what they have learned in the classroom to real-world problems at the forefront of science and technology. They have (perhaps for the first time) the opportunity to ask new questions, solve unsolved problems, or develop new devices or processes. They learn to work with the ambiguity brought by not knowing the next steps or one question leading to many new questions.

Undergraduate research is an apprenticeship. The mentor teaches through example and coaching, and students learn by doing. Delving into a problem and exploring the unknown provide the best learning environment for most students. Students develop critical thinking and analytical skills. As they take intellectual ownership of a project, they often develop the ability to make research decisions, learn the questions to ask, and gain the confidence to ask questions.

- Frequently Asked Questions
- Ask a Question
- Comments

Maria Berrios at NASAAmes

Cell Biology Education
Vol. 3, 022–027, Spring 2004

Features: Points of View

Should Students Be Encouraged To Publish Their Research in Student-Run Publications?

Note from the Editors
Points of View (POV) addresses issues faced within life science education. Cell Biology Education has launched the POV feature to present two or more opinions published in tandem on a common topic. We consider POVs to be "Op-Ed" pieces designed to stimulate thought and dialog on significant educational issues. Each author has the opportunity to revise a POV after reading drafts of the other POVs. In this issue, we ask the question, "Should students be encouraged to publish their research in student-run publications?" This question has been debated at institutions and has presented a renewed challenge with the advent of open access publishing as exhibited by the Journal for Young Investigators *(http://www.jyi.org). Three POVs are presented. Scott Gilbert, Professor of Biology at Swarthmore College, is well-known for his developmental biology textbook. John Jungck, a CBE editorial board member and Professor of Biology at Beloit College, is founding director of BioQUEST. Margaret Harris (Physics, Duke University), Renée Mercuri (Science Journalism, University of Waterloo, and Joshua Tusin (Biology, Beloit College) are staff members of the* Journal of Young Investigators. *Vivian Seigel is the Executive Director of Public Library of Science (http://www.plos.org) and former Editor of the journal* Cell. *The authors bring a wealth of publishing experience and different points of view to the debate. Readers are encouraged to participate in the online discussion forum hosted by CBE at http://www.cellbioed.org/discussion/public/main.cfm.*

A Case Against Undergraduate-only Journal Publications

Scott F. Gilbert
Department of Biology
Swarthmore College
Swarthmore, PA 19081

WHILE there may be several positive arguments for undergraduate research journals, I think that the negatives far outweigh the values they may have.

My first argument is that a journal geared toward the publication of undergraduate research would significantly "up the ante" and increase the pressures on students. Right now, my undergraduates do not need a published paper to get into an excellent graduate school or medical school or to be competitive for a fellowship. What they need is a letter of recommendation, wherein I write that the student has drive, persistence, intellectual curiosity, and that she or he knows how to plan experiments with the appropriate controls. The fact that the student's research has not yet reached the publication stage is not considered a disadvantage. If there were an undergraduate research journal, such a publication might become an expected "credential."

The second argument against an undergraduate research journal is that it would significantly increase the stress on faculty. One of the joys of pursuing research at a primarily undergraduate institution (at least, after one has tenure) has been the ability to do the research without having to have a program with a 100% chance of success. Moreover, I can work on topics that might take years to accomplish (and which would never be assigned to a graduate student). The research that I have done on turtle shell development investigates an organism that has a breeding season of 3 months each year. By the time we know what to look for, we have to wait 9 months for the next experiment. When we publish a paper, there may be 3 years worth of students on it. It takes time to make such a paper, and I would not want to publish pieces of it so that each undergraduate could have a paper published by the time she or he applies for fellowships or graduate degree programs.

Another stress on faculty members may involve competition between those who publish in such journals and those who don't. Would such papers in undergraduate journals count toward tenure and promotion? Are they "real" papers? Should someone who builds a story over a number of years be penalized for not publishing it bit-by-bit and accruing numerous "publications"?

"Undergraduates:
Do Research,
Publish!"

AJUR
American Journal
of Undergraduate Research

JYI

Journal of Young Investigators

#Cell Biology Education (2004)
Free On-line from ASCB.org

Points of View
Cell Biology Education
Vol. 3: 22–27 (Spring 2004)

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Scott Gilbert
Swarthmore College

Points of View
Cell Biology Education
Vol. 3: 22–27 (Spring 2004)

It would be interesting to know if any article in these journals has been cited by anyone outside its home institution or whether any of the journals is indexed in searchable databases such as PubMed. In other words, the journals risk being little more than “vanity journals.”

Thus, I do not think that an undergraduate research journal provides benefits for the undergraduates that outweigh the costs of time and other resources. I also doubt that such a journal would have articles of significant benefit to science or the scientific community. Moreover, I believe that such a journal would only put more publication pressure on faculty members and weaken one of the fundamental reasons for pursuing research with undergraduates. The risks of publishing an undergraduate research journal outweigh any possible benefit such a journal might have. I think that there are other, more important places where we can put our limited funds and time.

Scott Gilbert
Swarthmore College

Points of View
Cell Biology Education
Vol. 3: 22–27 (Spring 2004)

RESEARCH is not complete until it is published. A science education is not complete until students fully participate in all aspects of professional scientific culture. This means they have to understand the values of the profession that they are joining. Although undergraduates are provided opportunities to recognize the importance of research, too often they fail to appreciate that research is not complete until it is published. Values of researchers necessarily include publishing, peer review, and priority, but these values are not part of textbook information, traditional labs, and mass lectures or accessible through passive learning. Occasionally, students are listed as co-authors of articles in professional journals, but typically they are credited for their work in the acknowledgments. Rarely are students fully involved in both the writing and peer review process. Full engagement and benefit in undergraduate research will not be realized until peer review and publication are standard expectations of these critical experiences.

Undergraduates: Do Research, Publish!

John R. Jungck, Margaret Harris, Renée Mercuri,and Joshua Tusin

Not only publications,

But awards as well and activism!

Davidson's Bacterial Computer Wins Gold in Synthetic Bio Competition

December 04, 2007

Contact: Bill Giduz

A team of student biologists representing Davidson and collaborators from Missouri Western State University recently brought home the gold from the 2007 international Genetically Engineered Machines (iGEM) Competition. Their work, which involved constructing a "bacterial computer," began in May of 2007, when four Davidson students and two from outside the college took on the project full-time in the college's genomics lab. Funding for the project came from the Howard Hughes Medical Institute and Davidson Research Initiative.

The Davidsonians on the team celebrated their achievement with ice cream recently. They are (back l-r) Karmella Haynes, Jim Dickson, Malcolm Campbell, and (front l-r) Andrew Martens, Will DeLoache, and Laurie Heyer.

It was the third year Davidson has sent a team to the competition, which attracts synthetic biology teams from around the world. This year's Davidson effort built on last year's project of "flipping" genetic material to represent the stacking of burned pancakes of different sizes into correct order and orientation. This year's *E. coli* "computer" flipped genetic material to solve a mathematical puzzle called the Hamiltonian Path Problem.

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spusa@spusa.org
www.spusa.org

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About SPUSA: Mission and History

The mission of Student Pugwash USA is to promote social responsibility in science and technology.

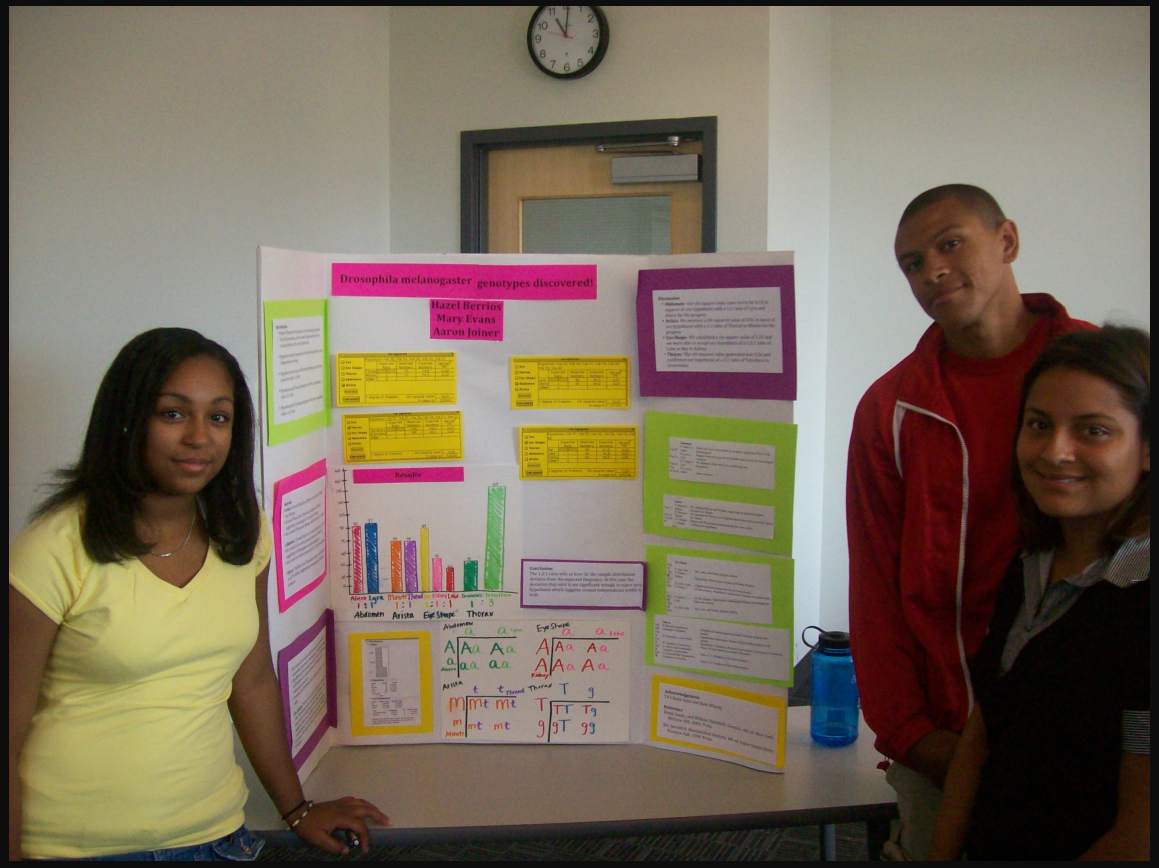
We prepare science, technology and policy students to make social responsibility a guiding focus of their academic and professional endeavors by:

- Examining the societal impacts of science and technology;
- Creating open and objective forums for debate;
- Fostering the exchange of ideas among diverse communities;
- Exploring solutions to current dilemmas in science and technology; and
- Cultivating the analytical skills needed to address future challenges.

SPUSA is guided by a respect for diverse perspectives and, as such, does not adopt advocacy positions on substantive issues. In order to create effective change, students first must understand the issues at stake, become trained in social activism, and contemplate their ethical and moral responsibility to themselves, and to society as a whole.

A student founded SPUSA in 1979 with the fundamental belief that young people play a vital role in determining the socially responsible application of science and technology. In 1955 Albert Einstein, Bertrand Russell, and other eminent scientists issued a manifesto urging scientists to "think in a new way" about their moral responsibilities in the nuclear age. In 1957, the first Pugwash Conference was held in Pugwash, Nova Scotia, bringing together some of the greatest scientific minds to address nuclear weapons issues and the social responsibility of scientists. SPUSA strives to convene the next generation of scientists around today's parallel issues.

SPUSA is the US student affiliate of the Pugwash Conferences on Science and World Affairs, recipients of the 1995 Nobel Peace Prize.



MENTORING: AFFECTIVE, SOCIAL, CULTURAL

Adv in Health Sci Educ (2010) 15:167–183
DOI 10.1007/s10459-009-9190-2

ORIGINAL PAPER

Effects of an educational intervention on female biomedical scientists' research self-efficacy

Lori L. Bakken · Angela Byars-Winston · Dawn M. Gundermann · Earlise C. Ward · Angela Slattery · Andrea King · Denise Scott · Robert E. Taylor

Received: 10 February 2009 / Accepted: 16 August 2009 / Published online: 23 September 2009

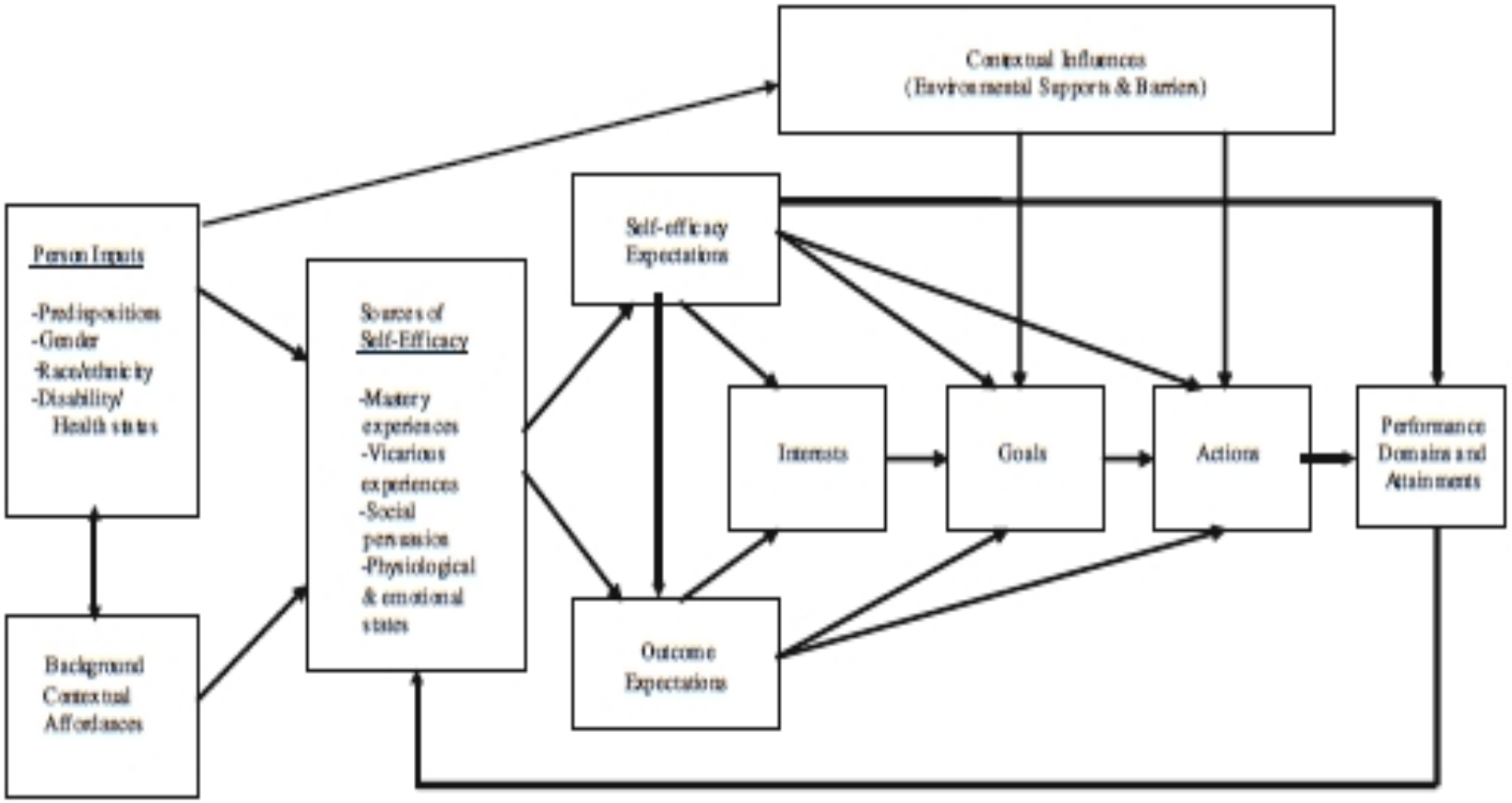
Abstract Women and people of color continue to be underrepresented among biomedical researchers to an alarming degree. Research interest and subsequent productivity have been shown to be affected by the research training environment through the mediating effects of research self-efficacy. This article presents the findings of a study to determine whether a short-term research training program coupled with an efficacy enhancing intervention for novice female biomedical scientists of diverse racial backgrounds would increase their research self-efficacy beliefs. Forty-three female biomedical scientists were randomized into a control or intervention group and 15 men participated as a control group. Research

Advances in Health Sciences Education (2006) 11: 91–110
DOI 10.1007/s10459-005-3138-y

Reflections

Viewing Clinical Research Career Development Through the Lens of Social Cognitive Career Theory

LORI L. BAKKEN[1,*], ANGELA BYARS-WINSTON[2] and MIN-FEN WANG[3]



A depiction of the key constructs and processes in Social Cognitive Career Theory. Note: Adapted from "Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice and Performance" by Lent et al. (1994).

Talking about Leaving: Why Undergraduates leave the Sciences

Elaine Seymour and Nancy Hewitt (Westview, 1997)

Reviewed by Danielle R. Bernstein (danny@hikertohiker.org)

ABSTRACT

Elaine Seymour and Nancy Hewitt are sociologists at the Bureau of Sociological Research at the University of Colorado in Boulder. The book is an indepth report of a huge, multi-campus study of Science, Math and Engineering (SME) students. Who sticks with SME and who switches out to another field? This review concentrates on the gender attributes and traits of switchers and nonswitchers

Most Important Single Generalization

Switchers and nonswitchers did not differ by individual attributes of performance, attitude and behavior. They had the same array of abilities, motivations and behaviors. What distinguished the survivors from those who left was the development of particular attitudes, coping strategies and serendipity. Few switchers (10%) left because they have discovered that a non-science discipline was more suited to their abilities. There was no gender difference in this regard. Non switchers cited intrinsic interest in the subject as a prime source of motivation more than twice as commonly as switchers.

Individual coping skills include:
Competence - knowing the material
Confidence - knowing that you know the material
Persistence - stick with it
Assertiveness
Strong interest in the discipline
Strong interest in the career
A support system, bonding with other women in SME

Talking about leaving:
Why undergraduates leave the sciences

"Field switching is only the tip of an iceberg: The same set of problems that prompt some science, mathematics, and engineering undergraduates to leave make persistence difficult for those who stay." (Cover jacket).

"Contrary to the common assumption that most switching is caused by personal inadequacy in the face of academic challenge, one strong finding is the high proportion of factors cited as significant in switching decisions which arise either from structural or cultural sources within institutions, or from students' concerns about their career prospects (p. 32)." The four most commonly cited concerns leading to switching decisions (also cited by between 31 and 74 percent of the non-switchers) were:

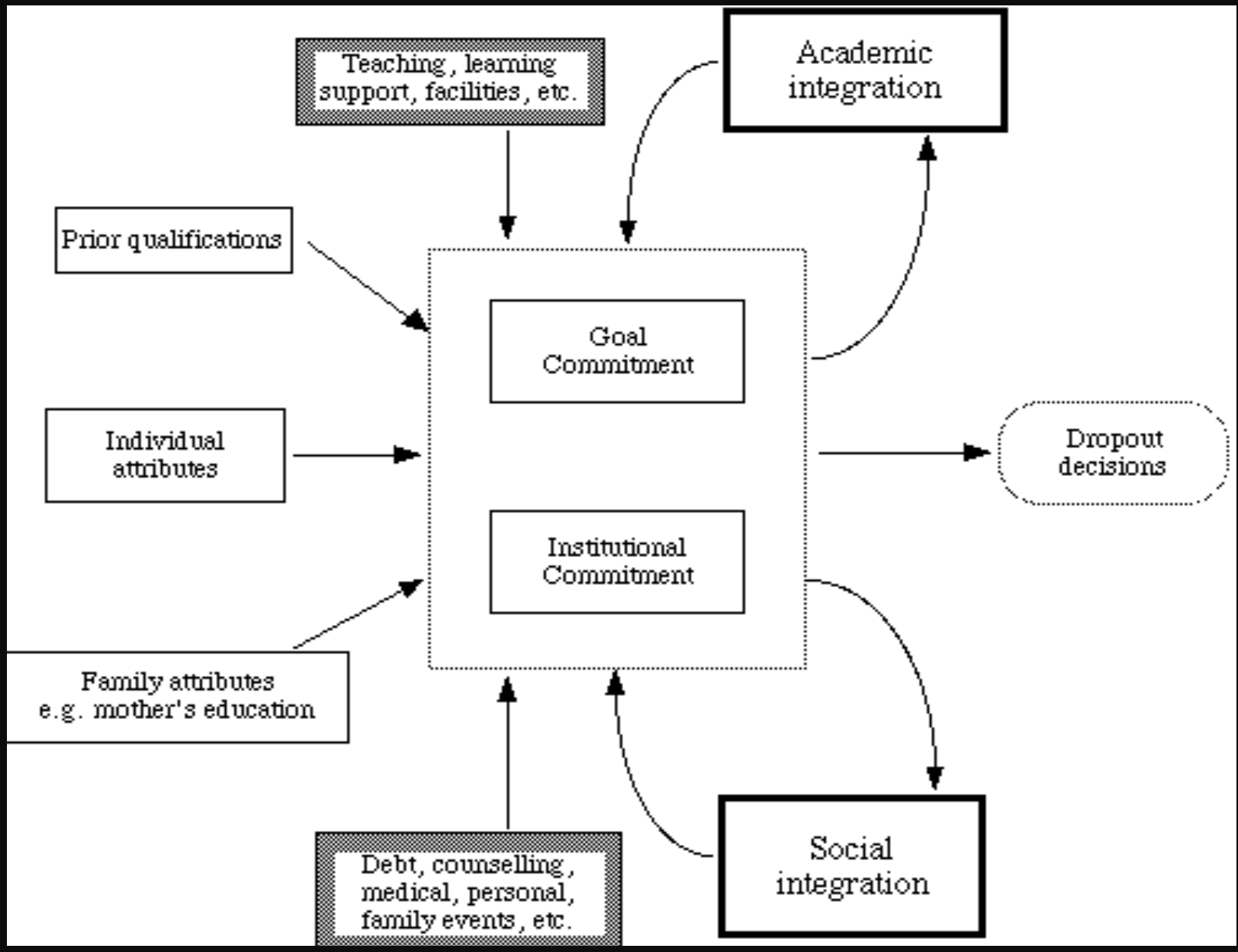
1. **Lack or loss of interest in science**
2. **Belief that a non-S.M.E. major holds more interest, or offers a better education**
3. **Poor teaching by S.M.E. faculty**
4. **Feeling overwhelmed by the pace and load of curriculum demands.**

Tinto's principles of effective retention:

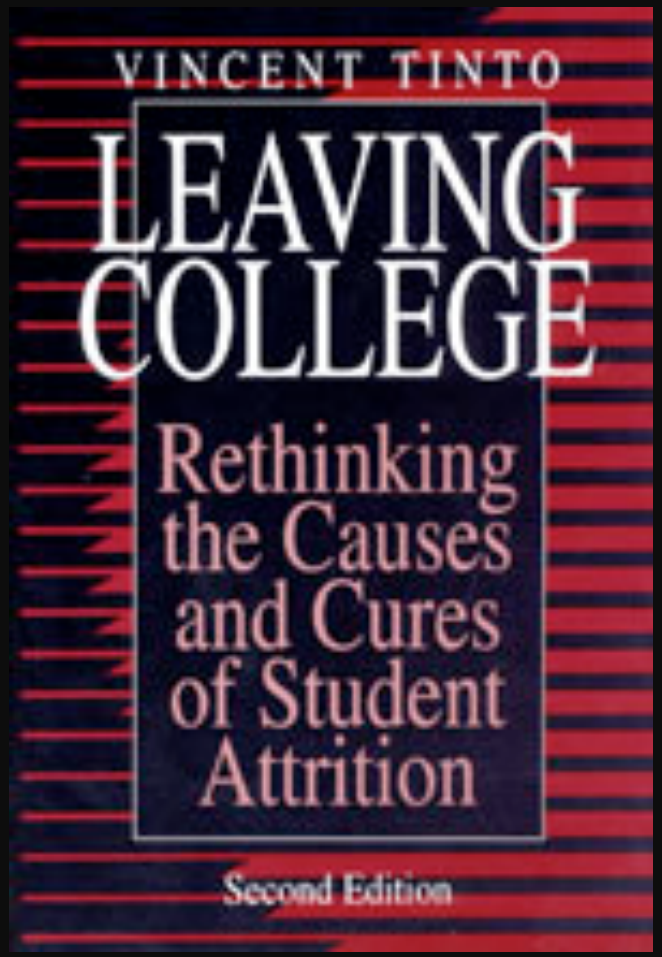
1. **Effective retention programs are committed to the students they serve. They put student welfare ahead of other institutional goals.**
2. **Effective retention programs are first and foremost committed to the education of all, not just some, of their students.**
3. **Effective retention programs are committed to the development of supportive social and educational communities in which all students are integrated as competent members.**

Commonalities of effective retention commitments:

- **enduring commitment to student welfare**
- **a broader commitment to the education, not mere retention, of all students**
- **an emphasis upon the importance of social and intellectual community in the education of students.**

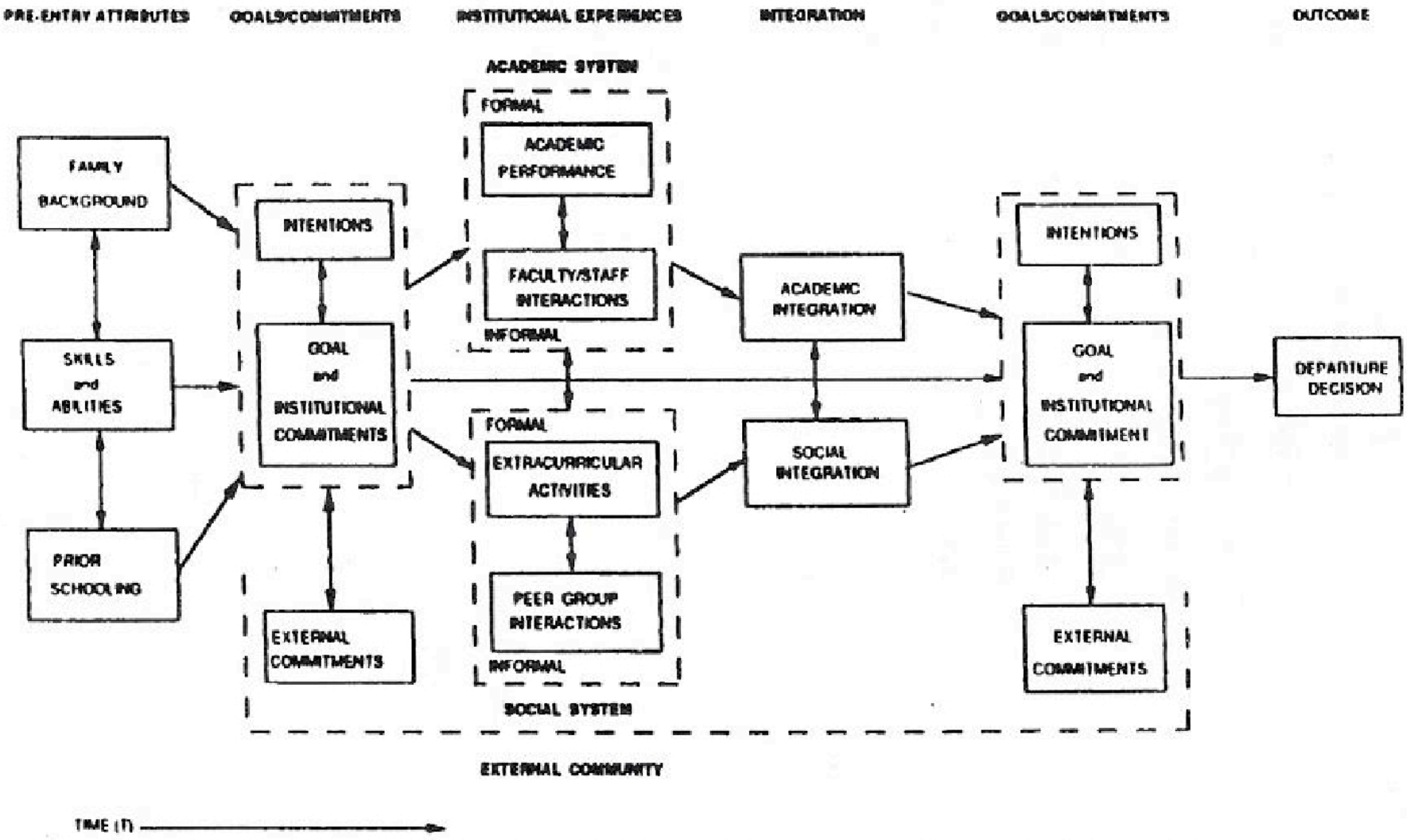

Teaching, learning support, facilities, etc.
Academic integration
Prior qualifications
Goal Commitment
Individual attributes
Dropout decisions
Institutional Commitment
Family attributes e.g. mother's education
Debt, counselling, medical, personal, family events, etc.
Social integration

Tinto Model



"Although programs can be most helpful, they cannot replace the absence of a high quality, caring, and concerned faculty and staff. Institutions should therefore not be misled by the use of modern technology and marketing strategies. . .The road to institutional commitment and thus to student commitment does not require very elaborate or high- cost interventions. . .Rather, effective retention calls for sustained effort of the part of all institutional members to give to each and every student serious and honest attention on a daily basis. It requires, if you will, a continuing commitment to the education of students. No technology, however sophisticated, can replace that sort of commitment (Tinto, p. 201)."

Tinto's Model of Voluntary Student Departure



Source: Vincent Tinto. 1993. Leaving College: Rethinking the Causes and Cures of Student Attrition. 2nd edition. Chicago: The University of Chicago Press, p. 114. Copyright 1987, 1993 by The University of Chicago Press.

What is a **peer**-reviewed publication?

- Evaluation of your research and your proposed publication/presentation by colleagues with similar knowledge and experience. Usually done anonymously.

• What is the value of **peer-review**?

- Part of self-regulation of profession
- Many readers don't have the expertise to judge the quality and importance of the research.
- Helps identify which projects to fund
- Helps identify which research findings to publish
- Helps in personnel reviews (who to hire andpromote)
- Assesses the reliability of research &findings

Sources

- *Journal of Young Investigators*, www.jyi.org
- American Journal of Undergraduate Research, (<http://www.ajur.uni.edu/>)
- Thanks to: Steneck, Nicholas H., *Introduction to the Responsible Conduct of Research,* Office of Research Integrity, U.S.Dept. of Health & Human Services

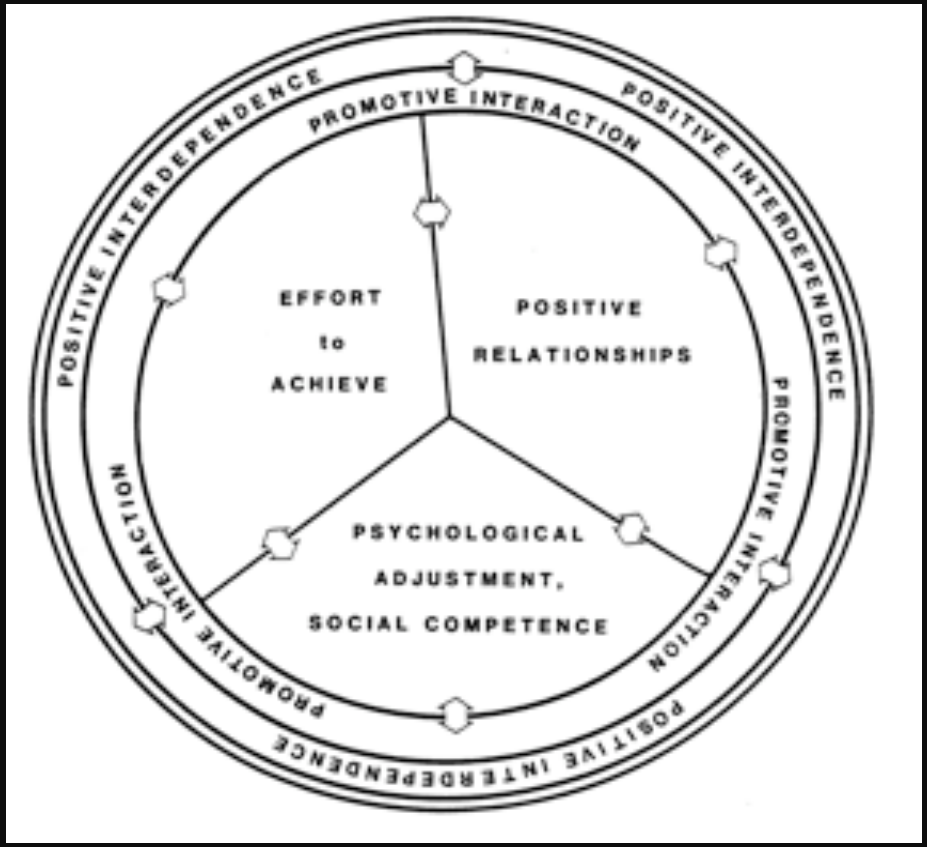
Cooperative Learning Research Support

Johnson, D.W., Johnson, R.T., & Smith, K.A. 1998. Cooperative learning returns to college: What evidence is there that it works? Change, 30 (4), 26-35.

- Over 300 Experimental Studies
- First study conducted in 1924
- High Generalizability
- Multiple Outcomes

Outcomes

1. Achievement and retention
2. Critical thinking and higher-level reasoning
3. **Differentiated views of others**
4. **Accurate understanding of others' perspectives**
5. **Liking for classmates and teacher**
6. Liking for subject areas
7. Teamwork skills



Small-Group Learning: Meta-analysis

Springer, L., Stanne, M. E., & Donovan, S. 1999. Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. Review of Educational Research, 69(1), 21-52.

Small-group (predominantly cooperative) learning in postsecondary science, mathematics, engineering, and technology (SMET). 383 reports from 1980 or later, 39 of which met the rigorous inclusion criteria for meta-analysis.

The main effect of small-group learning on achievement, persistence, and attitudes among undergraduates in SMET was significant and positive. Mean effect sizes for achievement, persistence, and attitudes were 0.51, 0.46, and 0.55, respectively.

How Undergraduate Research has changed undergraduate STEM education more generally

New Courses

New Modules

New Collaborations

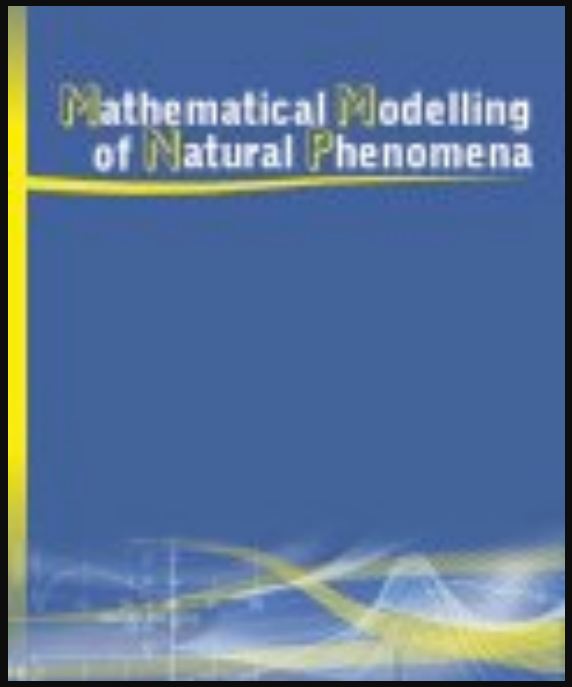
New Curricula

Transformed Syllabi & Revised Courses
(more emphasis on quantitative reasoning, data analysis, hypothesis testing, problem solving, modeling, …)

Team-Teaching

SLOVENIA

Andrej Šorgo
Faculty of Natural Sciences and Mathematics,
University of Maribor
Koroška c. 160
2000 Maribor,
SLOVENIA



Mathematical Modelling of Natural Phenomena

Special issue on Education (co-editor Elsa Schaeffer)

Sweet Briar College

Pitzger College

University of Chicago

Cleveland State University

Goucher College

Old Dominion University

Truman State University

SUNY Geneseo

University of Minnesota

Agnes Scott College

East Tennessee State University

St. Michael's College

DIMACS/Rutgers University

Universit´e Paris-VI – CNRS

Beloit College

create

C. R. E. A. T. E. =

Consider

Read

Elucidate hypotheses

Analyze &

interpret data

Think of next Experiment

GENETICS

Home Journal Information Subscriptions & Services Collections Previous Iss

Selective Use of the Primary Literature Transforms the Classroom Into a Virtual Laboratory

Sally G. Hoskins [*], [1], Leslie M. Stevens [†] and Ross H. Nehm [*§]

Author Affiliations

[1] *Corresponding author:* Biology Department, The City College of New York, Marshak Hall 607, 138th St. and Convent Ave., New York, NY 10031. E-mail: sallyh@sci.ccny.cuny.edu

Abstract

CREATE (*c*onsider, *r*ead, *e*lucidate hypotheses, *a*nalyze and interpret the data, and *t*hink of the next *e*xperiment) is a new method for teaching science and the nature of science through primary literature. CREATE uses a unique combination of novel pedagogical tools to guide undergraduates through analysis of journal articles, highlighting the evolution of scientific ideas by focusing on a module of four articles from the same laboratory. Students become fluent in the universal language of data analysis as they decipher the figures, interpret the findings, and propose and defend further experiments to test their own hypotheses about the system under study. At the end of the course students gain insight into the individual experiences of article authors by reading authors' responses to an e-mail questionnaire generated by CREATE students. Assessment data indicate that CREATE students gain in ability to read and critically analyze scientific data, as well as in their understanding of, and interest in, research and researchers. The CREATE approach demystifies the process of reading a scientific article and at the same time humanizes scientists. The positive response of students to this method suggests that it could make a significant contribution to retaining undergraduates as science majors.

Bringing Research Tools into Classroom/Laboratory/Field Education

Rethinking the Role of Information Technology-Based Research Tools in Students' Development of Scientific Literacy

Michiel van Eijck & Eolff-Michael Roth

Netherlands & Canada

J. Science Education & Technology 16 (3): 225-238 (June 2007)

IT Tools specifically designed as research tools; e.g., data-logging, image analysis, modeling, stat packages, bioinformatics, and phylogenetics

Only effective educationally if students apply to a problem that they have some ownership of and they use these IT tools "if students apply these tools with respect to the objectives of research activity and contribute to praxis of research by evaluating and modifying the application of these tools"

Modeling in Biology Education

Open access, freely available online

Community Page

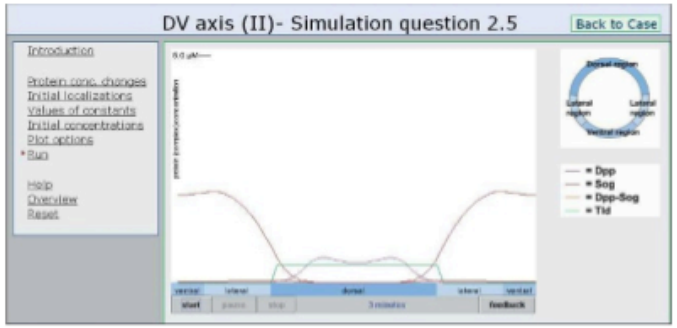
Biology by Numbers—Introducing Quantitation into Life Science Education

Tinri Aegerter-Wilmsen, Ton Bisseling*

Driven by the massive datasets that are generated by "omics" research, the molecular life sciences are entering a new phase. This phase is characterised by a shift in focus from individual genes and their products to networks and whole systems [1,2,3]. For a thorough analysis of the behaviour of networks and their underlying principles, quantitative tools are often necessary. Numerical simulations can, for example, be used to explore the behaviour of a network when the values of different parameters are varied, and, in turn, mathematical analysis can help to understand a particular biological phenomenon [2].

The successful application of quantitative tools in the molecular life sciences requires a good understanding of these tools and sufficient knowledge of the biological system under study. This can be achieved by collaboration between quantitatively trained scientists such as physicists on the one hand and biologists on the other. However, cultural differences hamper such collaboration [1]: even at the undergraduate level, students in the different disciplines speak very different languages [4].

A more productive approach is therefore to prepare students better for the quantitative nature of the molecular life sciences by integrating quantitative thinking and biology in the life science curriculum. This



DOI: 10.1371/journal.pbio.0030001.g001

Figure 1. A Simulation That Students Can Perform
After several minutes, Dpp forms one peak in the centre of the dorsal region, as in the wild type. The various elements of the quantitative model can be entered under "protein conc. changes", "initial localizations", "values of constants", and "initial concentrations". The numerical simulation itself shows the dynamic behaviour of the designed quantitative model.

themselves, covering topics such as cell biology, developmental biology, and biochemistry. We consider this important because it will help to show students how quantitative tools can be used to address various cutting edge questions in biology.

A Modelling Module in Developmental Biology

As an example of the integration of quantitative teaching and cutting edge biology, we have implemented an educational module in which

process. Therefore, a pattern-forming mechanism was selected that can initially be rather hard to understand: the generation of the morphogen gradient formed by the extracellular signalling molecule decapentaplegic (Dpp) early during *Drosophila* embryogenesis [5]. The generation of this gradient results from the fact that

Citation: Aegerter-Wilmsen T, Bisseling T (2005) Biology by numbers—Introducing quantitation into life science education. PLoS Biol 3(1): e1.

PLoS Biology 3(1): e1 (2005)

Digital Learning Material for Model Building in Molecular Biology

Tinri Aererter-Wilmsen *et al.*
Universität Wageningen
Netherlands

***Drosophila* morphogen gradient**

- **regulation at gene expression level**
- **role of gradients**
- **presence of positive feedback**

found design cycle transferable to other modeling activities

easy to adopt & adapt (University of Zurich, Switzerland)

Science Education and Technology 4 (1): 123-134 (2005)

BioQUEST & 3P's

- Problem Posing
- Problem Solving
- Peer Persuasion

Exploring Cyberlearning in Biology Education

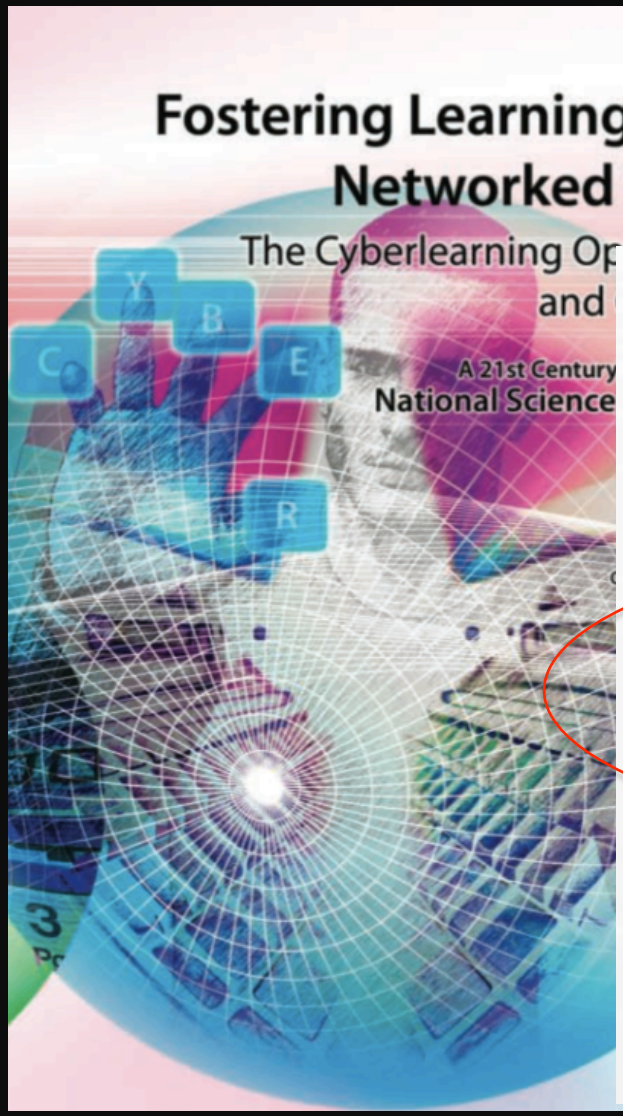
ASMcue.org

BioQUEST
Community Resources for Problem Solving in Biology

C3

NSF

What is Cyberlearning?



2005). We found, however, that use of this term was largely confined to NSF reports. Instead, we coined the term "cyberlearning," defined as follows:

Cyberlearning: learning that is mediated by networked computing and communications technologies.

The choice of the term is deliberately parallel to "cyberinfrastructure," a term coined at NSF[3] and now widely used there and elsewhere. In the

Advantages of Undergraduate Research

Undergraduate Research:

Engagement,
Mentoring,
and
Reform

ESCALATE: The White Book

Edited by Baruch Schwarz
The Hebrew University of Jerusalem

This book is an elaborated version of Deliverable D5.1 – "ESCALATE's White Book on Argumentation - and Enquiry-Based Science Learning" – submitted as part of the R&D project "ESCALATE". This project was co-funded by the European Commission within the Sixth Framework Programme (2002-2006) – project number: 020790 (SAS6).

Israel

(France, England, Greece, Switzerland & Italy, and Israel)
Argumentation in support of student scientific inquiry

later:
Marcia Linn
U C Berkeley
&
Philip Bell
U Washington

SCOPE
Science Controversies Online

even later
Science article on
MIT Project

Engaging Students in Science Controversy Through an Augmented
Reality Role-Playing Game

Eric Rosenbaum, Eric Klopfer, Britton Boughner
MIT

National Laboratory Practical

An Inquiry Oriented Laboratory Examination

Pinchas Tamir

Hebrew University of Jerusalem

J Educational Measurement 11 (1): 25-33 (Spring 1974)

Manipulation

Self-Reliance

Observation

Experimental Design

Communication

Reasoning

Practical counts 40% of total score