

**Gender Issues in Science/Math Education (GISME):  
Over 700 Annotated References & 1000 URL's –  
Part 2: Some References in *Subject Order* \* † § ◊**

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***Abstract***

This 12.8 MB compilation of over 700 annotated references and 1000 hot-linked URL's provides a window into the vast literature on *Gender Issues in Science/Math Education* (GISME). The present listing is an update, expansion, and generalization of the earlier 0.23 MB *Gender Issues in Physics/Science Education* (GIPSE) by Mallow & Hake (2002). Included in references on general gender issues in science and math, are sub-topics that include:

- (a) Affirmative Action;
- (b) Constructivism: Educational and Social;
- (c) Drivers of Education Reform and Gender Equity: Economic Competitiveness and Preservation of Life on Planet Earth;
- (d) Education and the Brain;
- (e) Gender & Spatial Visualization;
- (f) Harvard President Summers' Speculation on Innate Gender Differences in Science and Math Ability;
- (g) Hollywood Actress Danica McKellar's book *Math Doesn't Suck*;
- (h) Interactive Engagement;
- (i) International Comparisons;
- (j) Introductory Physics *Curriculum S* (for Synthesis);
- (k) Is There a Female Science? – Pro & Con;
- (l) Schools Shortchange Girls (or is it Boys)?;
- (m) Sex Differences in Mathematical Ability: Fact or Artifact?;
- (n) Status of Women Faculty at MIT.

In Part 1 (8.2 MB), *all* references are listed in *alphabetical order* on pages 3-178. In this Part 2 (4.6 MB) references related to sub-topics "a" through "n" are listed in *subject order* as indicated above.

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\*Partially supported by NSF Grant DUE/MDR-9253965.

† The reference is Hake, R.R. & J.V. Mallow. 2008. *Gender Issues in Science/Math Education (GISME): Over Seven Hundred Annotated Reference & 1000 URL's: Part 1 – All References in Alphabetical Order; Part 2 – Some References in Subject Order*; both online as ref. 55 at <<http://www.physics.indiana.edu/~hake/>> and at <<http://www.luc.edu/physics/faculty/mallow.shtml>>.

◊ This is a continually updated database. Comments and suggestions are welcomed by Richard Hake <[rjhake@earthlink.net](mailto:rjhake@earthlink.net)> and Jeffry Mallow <[jmallow@luc.edu](mailto:jmallow@luc.edu)>.

§ We thank Linda Schmalbeck, manager of Sigma Xi's education programs, whose request for information on gender issues in physics education during a 2002 PKAL meeting initiated our literature searches; and Cathy Kessel, president of the "Association for Women in Mathematics" (AWM) for furnishing several valuable math/science education references.

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### *Notes On References*

- (1) Tiny URL's courtesy <<http://tinyurl.com/create.php>>.
- (2) All URL's were accessed during the period 27 April – 10 July 2008.
- (3) The reference formatting takes advantage of the *best* features of the style manuals of the:
  - (a) American Institute of Physics (AIP), (b) American Psychological Association (APA), and
  - (c) Council of Science Editors (CSE). This *optimum* formatting is not often employed, but should be.
- (4) The notation “online to subscribers at <<http://www.....>>” often means that non-subscribers can access an abstract and buy the full article at the same URL.
- (5) A few education-related references (preceded by asterisks\*) are included which are only tangentially related to gender because we think that progress towards gender (and minority) equity in science & math education requires the general reform of K-16 science/math education for *ALL* students.
- (6) As indicated in the *Abstract*, included in references to general gender issues in science and math on pp. 3-178 of Part 1 are references to sub-topics. The latter are preceded by superscripts #XY:
  - (a) Affirmative Action: #AA ;
  - (b) Constructivism: Educational and Social: #CE , #CS ;
  - (c) Drivers of Education Reform and Gender Equity: Economic Competitiveness and Preservation of Life on Planet Earth: #EC , #LPE ;
  - (d) Education and the Brain: #EB ;
  - (e) Gender & Spatial Visualization: #SV ;
  - (f) Harvard President Summers’ Speculation on Innate Gender Differences in Science and Math Ability: #SSIGD ;
  - (g) Hollywood Actress Danica McKellar’s book *Math Doesn’t Suck*: #DM ;
  - (h) Interactive Engagement: #IE ;
  - (i) International Comparisons: #IC ;
  - (j) Introductory Physics Curriculum S (for Synthesis): #IPCS ;
  - (k) Is There a Female Science? – Pro & Con: #FSP, #FSC ;
  - (l) Schools Shortchange Girls (or is it Boys): #SSG , #SSB ;
  - (m) Sex Differences in Mathematical Ability: Fact or Artifact?: #SDMA
  - (n) Status of Women Faculty at MIT: #MIT .

Thus, e.g., a search for “#AA” (without the quotes) will bring up references related to “Affirmative Action.”

- (7) As indicated in the *Abstract*, in Part 1 (8.2 MB) *all* references are listed in *alphabetical order* on pages 3-178. In this Part 2 (4.6 MB) references relevant to sub-topics “a” – “n” in “6” above are listed in *subject order* as indicated in the *Table of Contents* on page 3.

#### **(8) Why Bother?**

Alice Rossi (1965), seventy-fourth president of the American Sociological Association, stated: “American society has prided itself on its concern for the fullest development of each individual’s creative potential. As a nation, we have become sensitive to the social handicaps of race and class but have remained quite insensitive to those imposed because of sex.” Forty-three years later, gender inequity still handicaps the nation’s creative and productive potential. In *Beyond Bias and Barriers: Fulfilling the Women in Academic Science and Engineering* [NAP (2007a)], the National Academy’s “Committee on Maximizing the Potential of Women in Academic Science and Engineering” states: “The United States economy relies on the productivity, entrepreneurship, and creativity of its people. To maintain its scientific and engineering leadership amid increasing economic and educational globalization, the *United States must aggressively pursue the innovative capacity of all its people—women and men.*” [Our *italics*.] Not to mention the vital role women in science and math can play in helping to preserve life on planet Earth! – see Part 2, Section C2.

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## A. Affirmative Action <sup>#AA</sup>

<sup>#AA</sup> AAS. 1992. American Astronomical Society, *The Baltimore Charter for Women In Astronomy*, online at <<http://www.aas.org/cswa/bc.html>>.

<sup>#AA</sup> AAS. 2005. American Astronomical Society, *The Pasadena Recommendations for Gender Equality in Astronomy*; online at <<http://www.aas.org/cswa/pasadenarecs.html>> and as a pdf at <[http://www.aas.org/cswa/Equity\\_Now\\_Pasadena.pdf](http://www.aas.org/cswa/Equity_Now_Pasadena.pdf)> (144 kB).

<sup>#AA</sup> AAS. 2005. American Astronomical Society Sets Goals for Improving Gender Equity in Astronomy; online at <<http://www.aas.org/policy/PR/2005/equity.html>>.

<sup>#AA</sup> Bhattacharjee, Y. 2007. "Gender Equity: U.S. Agencies Quiz Universities on the Status of Women in Science," *Science* **315** (5820): 1776, summary online at <<http://tinyurl.com/4x5f62>>:

"Officials from the U.S. National Science Foundation, the Department of Energy, and NASA have visited four academic departments on three campuses in the past 14 months to monitor their compliance with a 1972 law that prohibits sex discrimination in educational programs and activities receiving federal funds."

<sup>#AA</sup> Canizares, C. R. 1999. "Commentary," *STATUS*, June; online at <[http://www.aas.org/cswa/status/status\\_june99.pdf](http://www.aas.org/cswa/status/status_june99.pdf)> (320 kB). Canizares wrote:

"To paraphrase Mark Twain, recent reports of the death of discrimination have been greatly exaggerated. These accounts accompany a pernicious surge in legal and political challenges to affirmative action programs, based in part on the premise that such efforts are no longer needed. It is true that significant progress has been made in swelling the ranks of both women and minorities in some areas where they have been previously underrepresented, from Cabinet offices to Boardrooms to the tenured ranks of research universities. The fact that people bother attacking affirmative action programs is itself a sign that, whatever their shortcomings, they have had effect . . . . Where should we be in terms of the representation of women in astronomy? *I strongly believe the only conceivable answer is that women, and indeed all segments of society, should be represented roughly in proportion to their representation in the population at large.*" (Our *italics*.) [Canizares is the Bruno Rossi Professor of Experimental Physics and Director of the Center for Space Research at MIT.]

<sup>#AA</sup> Gelernter, D. 2000. "Women and Science at Yale," *STATUS*, January; online at

<[http://www.aas.org/cswa/status/status\\_jan00.pdf](http://www.aas.org/cswa/status/status_jan00.pdf)> (256 kB). Gelernter wrote (our *italics*):

"Affirmative action seems to be entering a new phase: As the public turns against it, universities are growing increasingly desperate in their support. *I teach at Yale, where the administration has made it clear that (in particular) it wants more female professors in technology and the hard sciences.* Other universities have the same goal; they have longed for women scientists for years, but their longing seems to have entered a new phase of grim determination. . . . the Yale administration is doing the academic world no favor by joining the crowd that has gathered to poke and prod this particular hornets' nest. The approaching hornet swarm is bad news for universities and society in general. Whether or not you approve of affirmative action, it's clear that certain of its goals can be achieved and others can't. If you are determined, say, to increase the proportion of Hispanics in your undergraduate population, you can probably do it; Hispanic applicants are available. *If your goal is a large increase in female science and engineering professors, you can't do it, because the candidates are not available.*" (Our *italics*.)

#AA Georgi, H. 2000c. "Views From an Affirmative Activist," *STATUS*, January; online at <[http://www.aas.org/cswa/status/status\\_jan00.pdf](http://www.aas.org/cswa/status/status_jan00.pdf)> (256 kB). Georgi wrote:

"Affirmative action seems to have become a divisive issue. I think that this is sad, because I believe that there are situations in which it should not be controversial, if properly understood. I feel strongly that affirmative action to encourage women in science continues to be important, and today I want to explain why. In my view, there are two basic and related issues — evaluation and climate. I firmly believe that improvements in these areas will be good for everyone, not just women."

#AA Malcom, S.M., D.E. Chubin, J.K. Jesse. 2004. *Standing Our Ground: A Guidebook for STEM Educators in the Post-Michigan Era* AAAS and NACME (National Action Council for Minorities in Engineering); online as a 4.6 MB pdf at <<http://tinyurl.com/yv39jg>>.

#AA Rolison, D.R. 2003. "Can Title IX Do for Women In Science and Engineering What It Has Done for Women In Sports?" APS News, May, online at <<http://www.aps.org/publications/apsnews/200305/backpage.cfm>>.

#AA Urry, M. 1999. "The Baltimore Charter and the Status of Women in Astronomy," *STATUS*, June; online at <[http://www.aas.org/cswa/status/status\\_june99.pdf](http://www.aas.org/cswa/status/status_june99.pdf)> (320 kB). Urry wrote:

"The purpose of the Baltimore Charter was to suggest concrete action (not just griping) to improve the status of women in astronomy. It represents the consensus of many views, with input from a significant fraction of the active astronomical community. . . . It was released in June 1993 at the semi annual meeting of the American Astronomical Society, receiving a lot of attention from the national press and popular science publications. In subsequent months the Baltimore Charter and/or its goals were endorsed by the AAS, NASA, NSF, AURA, and several prominent universities. . . . The Charter states five basic premises and briefly justifies them . . . A key assertion is that positive action is required to change the status quo, hence the five major recommendations of the Charter. *The most important of these, and the most controversial, is the statement that 'Affirmative action is a necessary part of the solution'* . . . . The Charter ends with a call to action, to all our colleagues, to facilitate the full participation of women. . . . There was no mass movement to endorse the Baltimore Charter or to implement its recommendations widely, although it appears to have helped some individual women, especially those isolated in small departments."

#AA USGAO. 2004. United States Government Accountability Office, "GENDER ISSUES: Women's Participation in the Sciences Has Increased, but Agencies Need to Do More to Ensure Compliance with Title IX," July, online at <<http://www.gao.gov/new.items/d04639.pdf>> (4.9 MB).

## B. Constructivism: Educational and Social #CE #CS

#FSC #CS Almeder, R.F., N. Koertge, & C.L. Pinnick, eds. 2003. *Scrutinizing Feminist Epistemology: An Examination of Gender in Science*. Rutgers University Press; publisher's information at <<http://tinyurl.com/4u883j>> Amazon.com information at <<http://tinyurl.com/29rtf4>>:

Book Description (our *italics*):

This volume presents the first systematic evaluation of a feminist epistemology of science's power to transform both the practice of science and our society. Unlike existing critiques, *this book questions the fundamental feminist suggestion that purging science of alleged male biases will advance the cause of both science and by extension, social justice.*

The book is divided into four sections: the strange status of feminist epistemology, testing feminist claims about scientific practice, philosophical and political critiques of feminist epistemology, and future prospects of feminist epistemology. Each of the essays - most of which are original to this text - directly confronts the very idea that there could be a feminist epistemology or philosophy of science. *Scrutinizing Feminist Epistemology* provides a timely, well-rounded, and much needed examination of the role of gender in scientific research.

#CE \*Ansbacher, T. 2000. "An interview with John Dewey on science education," *Phys. Teach.* 38(4): 224-227; online at <<http://tinyurl.com/3rdxpc>> as a 1.3 MB pdf. A thoughtful and well-researched treatment showing the consonance of Dewey's educational ideas (as quoted straight from Dewey's own writings, not from the accounts of sometimes confused Dewey interpreters) with the thinking of most current science-education researchers. Ansbacher's valuable web site is at <[http://web.mac.com/tedans/Science\\_Services/Welcome.html](http://web.mac.com/tedans/Science_Services/Welcome.html)>. A segment of Ansbacher's simulated interview dealing with educational constructivism is as follows:

Ansbacher: Can you state for us what you see as the guiding principle for the kind of experience-based education you are describing?

Dewey: Education must be conceived as a continuing reconstruction of experience; that the process and the goal of education are one and the same thing. [It does not mean, as it is often misunderstood,] that we have no choice save either to leave the child to his own unguided spontaneity or to inspire direction upon him from without. But [it recognizes] that no such thing as...insertion of truth from without is possible. All depends upon the activity which the mind itself undergoes in responding to what is presented from without.

Ansbacher: *This sounds in line with what today is called the constructivist position.* [Our *italics*.] What role, then, does this leave for the teacher?

Dewey: [The role of] the educator is *to determine the environment of the child*, and thus by indirection to direct. Growth depends upon the presence of difficulty to be overcome by the exercise of intelligence. It is part of the educator's responsibility to see equally to two things: First, that the problem grows out of the conditions of the experience being had in the present, and that it is within the range of the capacity of students; and, secondly, that it is such that it arouses in the learner an active quest for information and for production of new ideas. The new facts and new ideas thus obtained become the ground for further experiences in which new problems are presented. The process is a continuous spiral.

#CE \*Baxter Magolda, M.B. 2004. "Evolution of a Constructivist Conceptualization of Epistemological Reflection," *Educational Psychologist* 39(1): 31-42 (special issue on epistemology), abstract online at <<http://www.informaworld.com/smpp/content~content=a784755134~db=all~order=page>> :  
"The epistemological reflection model offers a constructivist theory of personal epistemology based on a 16-year longitudinal study. Participants' developmental journeys are intertwined with the researchers' journey to trace the evolution of the model and its implications for research and practice to promote personal epistemology."

#CE \*Cobb, P. 1994. "Where is the mind? Constructivist and sociocultural perspectives on mathematical development," *Educational Researcher* 23(7): 13–20; online at <<http://calteach.ucsc.edu/aboutus/documents/Cobb-construcandsocdevinmath.pdf>> (4.4 MB).

The abstract reads:

"Currently, considerable debate focuses on whether mind is located in the head or in the individual-in-social-action, and whether development is cognitive self-organization or enculturation into established practices. In this article, I question assumptions that initiate this apparent forced choice between constructivist and sociocultural perspectives. I contend that the two perspectives are complementary. Also, claims that either perspective captures the essence of people and communities should be rejected for pragmatic justifications that consider the contextual relevance and usefulness of a perspective. I argue that the sociocultural perspective informs theories of the conditions for the possibility of learning, whereas theories developed from the constructivist perspective focus on what students learn and the processes by which they do so."

#CS \*Cole, J.R. 1993. "Balancing Acts: Dilemmas of Choice Facing Research Universities," *Daedalus* 122(4); online at <<http://www.columbia.edu/cu/provost/docs/dilemmas.html>>. [Reprinted with permission of *Daedalus*, Journal of the American Academy of Arts and Sciences, from the issue entitled "The American Research University," Fall 1993, Vol. 122, No. 4]

4] Cole wrote:

"One of these . . . (dilemmas) . . is represented by a significant attack on the prevailing organizational axioms, or presuppositions, on which research universities have been built. A second is represented by a fundamental challenge to what John Searle calls 'the Western Rationalistic Tradition' in his essay in this volume of *Daedalus*. *This attack is leveled against the presuppositions of rationality, of objectivity, of truth, of 'there being a there out there,' among other basic epistemological and metaphysical presuppositions that have guided discourse throughout most of Western history, and certainly since the seventeenth century.* [Our italics.] These challenges to the university's organizational principles and to its philosophical presuppositions are interrelated. They involve conflicting views of the basic principles and what is required to prove that one or another organizational principle is right or wrong."

#CS \*Cole, J.R. 1996. "The Two Cultures Revisited," *The Bridge* (National Academy of Engineering) 26(3-4): 16-21; online at <<http://www.nae.edu/nae/bridgecom.nsf/weblinks/NAEW-4NHMJT?OpenDocument>> :  
"The gulf in understanding between scientists and nonscientists may be traceable to an educational system that neglects the historical importance of scientific and technological developments."

See the classic: *The two cultures and the scientific revolution* [Snow (1959)].

#CE #CS \*Curren, R., ed. 2007. *Philosophy of Education: An Anthology*. Blackwell.

Amazon.com information at <<http://tinyurl.com/2psk2q>>. Note the “Search Inside” feature. Contains four chapters on “Inquiry, Understanding, and Constructivism,” including a reprint of Phillips (1995). A marginally useful Google book preview” is online at <<http://tinyurl.com/25cgbp>>.

#CE \*diSessa, A.A. 1988. “Knowledge in Pieces,” in Forman & Pufall (1988), pp. 49-70; online at <<http://www.questia.com/PM.qst?a=o&d=13634588>>.

#CE \*Forman, G. & P.B. Pufall. 1988. *Constructivism in the Computer Age*. Lawrence Erlbaum; online at <<http://www.questia.com/PM.qst?a=o&d=13634588>>.

#CS \*Gottfried, K. and K.G. Wilson. 1997. "Science as a cultural construct," *Nature* 386: 545 - 547. They attack the “strong program” of the Edinburgh school of sociological constructivists. A brief summary with references (some hot-linked) is online at <<http://www.nature.com/nature/journal/v386/n6625/abs/386545a0.html>>. Gottfried & Wilson wrote:

“Scientific knowledge is a communal belief system with a dubious grip on reality, according to a widely quoted school of sociologists. But they ignore crucial evidence that contradicts this allegation.”

#CE & CS \*Grandy, R. 1997. “Constructivisms and Objectivity: Disentangling Metaphysics from Pedagogy,” *Science and Education* 6: 43-53; abstract online at <<http://tinyurl.com/6em2x4>> (our *italics*):

“We can distinguish the claims of cognitive constructivism from those of metaphysical constructivism, which is almost entirely irrelevant to science education. *Cognitive constructivism has strong empirical support and indicates important directions for changing science instruction*. It implies that teachers need to be cognizant of representational, motivational and epistemic dimensions which can restrict or promote student learning. The resulting set of tasks for a science teacher are considerably larger and more complex than on the older more traditional conception, but the resources of cognitive sciences and the history of science can provide important parts of the teachers intellectual tool kit. A critical part of this conception of science education is that students must develop the skills to participate in epistemic interchanges. They must be provided opportunities and materials to develop those skills and the classroom community must have the appropriate features of an objective epistemic community.”

#CE #CS \*Hackett, E.J., O. Amsterdamska, M. Lynch and J. Wajcman, eds. 2007. *The Handbook of Science and Technology Studies, Third Edition*. MIT Press, publisher’s information at <<http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=11368>> :

Endorsement:

“This *Handbook* does a superb job making sense of critical terrains where diverse sorts of expertise, bumptious publics, and generative practices of engagement are reshaping knowledges and their consequences under the sign of technoscience. It goes without saying that the bibliographies are full and tasty and the scholarly reviews invaluable for anyone who wants to be literate in our capacious field. It needs saying that many of the essays succeed in being inspiring, making me remember why a life in STS is worth the price of admission.” -- Donna Haraway, History of Consciousness Department, University of California, Santa Cruz

#CE \*Hake, R.R. 2001. "Re: Mathematics and Constructivism," online at <<http://mathforum.org/kb/thread.jspa?threadID=484332&tstart=4485>>. Post of 9 Dec 2001 22:01:00-0800 to Dewey-L, Math-Teach, and PhysLrnR.

#IE #CE \*Hake, R.R. 2008c. "Language Ambiguities in the Learning Sciences," submitted to the *Journal the Learning Sciences* on 4 March; online at <<http://www.physics.indiana.edu/~hake/LangAmbiguitiesC.pdf>> (2.1 MB) and as ref. 54 at <<http://www.physics.indiana.edu/~hake>>.

Contains a critique of "Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching" [Kirchner *et al.* (2006)].

#CE \*Hegedus, S.J. & J.J. Kaput. 2004. "An Introduction to the Profound Potential of Connected Algebra Activities: Issues of Representation, Engagement and Pedagogy." *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education* 3: 129–136; online at <[http://www.emis.de/proceedings/PME28/RR/RR261\\_Kaput.pdf](http://www.emis.de/proceedings/PME28/RR/RR261_Kaput.pdf)> (408 kB).

#CS \*Jasanoff, S., G.E. Markle, J.C. Peterson, & T. Pinch. 2001. *Handbook of Science and Technology Studies*. Sage, publisher's information at <<http://www.sagepub.com/booksProdDesc.nav?contribId=502493&prodId=Book225385>> : "This volume represents the social constructivist turn of the field. It is evident that social constructivism made a major impact on the field during the 1970s and 1980s. The diverse papers included here highlight the role of ethnography in STS. In addition, we are exposed to new perspectives of the multicultural and gendered nature of knowledge production." — *Science, Technology, and Society*

#CE #CS \*Kastrup, H. & J.V. Mallow. 2003. "Post-constructivism: A New Approach to Physics Pedagogy," *AAPT Announcer* 33(2):152; Madison, WI meeting of 2-6 August.

#CE \*Kirschner, P.A., J. Sweller, & R.E. Clark. 2006. "Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching." *Educational Psychologist* 41(2): 75-86; online at <<http://tinyurl.com/3xmp2m>> (176 kB).

For a critique see "Language Ambiguities in the Learning Sciences" [Hake (2008a)].

#FSC #CS Koertge, N. ed. 1998. *A House Built on Sand: Exposing Postmodern Myths About Science*. Oxford University Press, publisher's information at <<http://tinyurl.com/3824km>>. For anti-postmodernist comment on the work of Ruth Bleier, Donna Haraway, Sandra Harding, Evelyn Fox Keller, Helen Longino, and Londa Schiebinger see the corresponding index headings. For a more recent book in this vein see *Scrutinizing Feminist Epistemology: An Examination of Gender in Science* [Almeder *et al.* (2003)].

The back cover of Koertge (1998) carries a testimonial from Dudley Herschbach (1986 Chemistry Nobelist): "Critics as well as admirers of science will find in these essays much that deserves to be taken to heart, head, and hearth. Large wings of the rambling postmodern house suffer from shoddy work and rambling footing. This should help both cultural scholars and scientists to find bedrock for sturdy construction rather than cynical deconstruction."

#CS \*Larbinger, J.A. & H. Collins, eds. 2001. *The One Culture? A Conversation about Science*, University of Chicago Press. Amazon.com information at <<http://tinyurl.com/3t4kox>> Note the "Search Inside" feature. Publisher's information at <<http://www.press.uchicago.edu/cgi-bin/hfs.cgi/00/14218.ctl>>:

"So far the 'Science Wars' have generated far more heat than light. Combatants from one or the other of what C. P. Snow famously called 'the two cultures' (science versus the arts and humanities) have launched bitter attacks but have seldom engaged in constructive dialogue about the central issues. In *The One Culture?*, Jay A. Labinger and Harry Collins have gathered together some of the world's foremost scientists and sociologists of science to exchange opinions and ideas rather than insults. The contributors find surprising areas of broad agreement in a genuine conversation about science, its legitimacy and authority as a means of understanding the world, and whether science studies undermines the practice and findings of science and scientists.....Contributors include: Constance K. Barsky, Jean Bricmont, Harry Collins, Peter Dear, Jane Gregory, Jay A. Labinger, Michael Lynch, N. David Mermin, Steve Miller, Trevor Pinch, Peter R. Saulson, Steven Shapin, Alan Sokal, Steven Weinberg, & Kenneth G. Wilson."

#CE \*Lochhead, J. 1988. "Some Pieces of the Puzzle," in Forman & Pufall (1988), pp. 71-81, online at <<http://www.questia.com/PM.qst?a=o&d=13634588>>.

#CE #CS \*Mallow, J.V. 2007. "Constructivism in Physics Education – Philosophically Problematic, but Pedagogically Successful," AGORA Journal of Research, Development, and Concept Exchange in the Professions, online at <<http://www.cvustork.dk/filer/agora106constructivisminphysicseducation.pdf>> (148 kB).

#CE #CS \*Matthews, M.R. 1998. *Constructivism in Science Education: A Philosophical Examination*. Kluwer. Amazon.com information at <<http://tinyurl.com/6pq48r>>. Note the "Search Inside" feature. A Google "book preview is online at <<http://tinyurl.com/5w54hy>>.

#CE #CS \*Matthews, M.R. 2002. "Constructivism and Science Education: A Further Appraisal," *J. Sci. Educ. and Technol.* **11**(2): 121-134; abstract online at

<<http://www.springerlink.com/content/6mp7mbt9b0q9q7a/>>. The abstract reads:

"This paper is critical of constructivism. It examines the philosophical underpinnings of the theory, it outlines the impact of the doctrine on contemporary science education, it details the relativist and subjectivist interpretation of Thomas Kuhn's work found in constructivist writings, it indicates the problems that constructivist theory places in the way of teaching the content of science, and finally it suggests that a lot of old-fashioned, perfectly reasonable educational truisms and concepts are needlessly cloaked in constructivist jargon that inhibits communication with educationalists and policy makers."

#FSC #CS \*Newton, R. 1997. *The Truth of Science: Physical Theories and Reality*. Harvard University Press, publisher's information at

<<http://www.hup.harvard.edu/catalog/NEWTRU.html>> :

"To claims that science is a social construction, Newton answers with the working scientist's credo: 'A body of assertions is true if it forms a coherent whole and works both in the external world and in our minds.' The truth of science, for Newton, is nothing more or less than a relentless questioning of authority combined with a relentless striving for objectivity in the full awareness that the process never ends. With its lucid exposition of the ideals, methods, and goals of science, his book performs a great feat in service of this truth."

#CS \*Newton, R. 1998. "Guest Comment: The science wars." *Am. J. Phys.* **66**(4): 282-283; online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=66&Issue=4>>

Newton wrote:

"Most physicists are aware of what is generally referred to as the *science wars*, but their attitude tends to be dismissive—why should we waste our time arguing against the arrant nonsense of the 'social constructivists'? I believe this stance to be mistaken, not because I expect these critics to be capable of doing irreparable damage to science directly, but because those they teach will become future teachers of our young, legislators who write laws and dispense funds touching on science, voters who will elect them, and jury members who may have to make life or death decisions by judging scientific evidence. We should worry when those who look at species as cultural constructs are not concerned about their extinction. We should worry when those who think science is but 'politics by other means' refuse to give credence to scientists who conclude that high-voltage powerlines are harmless."

#CE #CS \*Phillips, D. C. 1995. "The good, the bad, and the ugly: The many faces of constructivism," *Educational Researcher* **24**(7): 5-12; online at

<<http://edr.sagepub.com/cgi/reprint/24/7/5>>. Reprinted in Curren (2006). Also reprinted with some changes and additions as Chapter 1 of Phillips (2000). See also Taber (2006). Phillips identifies the *ugly* as the quasi-religious or ideological aspects of constructivism and then writes:

"The *good* . . . is the emphasis that various constructivist sects place on the necessity for active participation by the learner, together with the recognition (by most of them) of the social nature of learning; it seems clear that, with respect to their stance on education, most types of constructivism are modern forms of progressivism. Constructivism also deserves praise for bringing epistemological issues to the fore in the discussion of learning and the curriculum. . . . The *bad* . . . . are constructivist epistemologies that tend (despite their occasional protestations to the contrary) toward relativism and make the justification of our knowledge-claims pretty much entirely a matter of sociopolitical processes or consensus, or that jettison any justification or warrant at all (as arguably the case with radical social constructivism)."

#CE #CS \*Phillips, D.C. 2000a. *Expanded social scientist's bestiary: a guide to fabled threats to, and defenses of, naturalistic social science*. Rowman & Littlefield; publisher's information at <<http://tinyurl.com/ycmlyv>>.

#CE #CS \*Phillips, D.C., ed. 2000b. *Constructivism in Education: Opinions and Second Opinions on Controversial Issues*. Ninety-ninth Yearbook of the National Society for the Study of Education, Part 1. University of Chicago Press, publisher's information at <<http://www.press.uchicago.edu/cgi-bin/hfs.cgi/00/14066.ctl>> :

*Constructivism in Education* is a lively discussion of the varieties of constructivist thought which have been applied to the teaching of school subjects, especially science and mathematics. Contributors include philosophers of education and specialists in science, mathematics, and childhood education.

#CE \*Resnick, L.B. and Hall, M.W. 1998. "Learning Organizations for Sustainable Education Reform," *Daedalus* 127(4): 89-118; ,online at <<http://ifl.lrdc.pitt.edu/ifl/media/pdf/learningorgforsustain.pdf>> (168 kB):

"Broadly speaking, cognitive science confirms Piaget's claim that people must *construct* (*italics* in the original) their understanding; they do not simply register what the world shows or tells them, as a camera or a tape recorder does. To 'know' something, indeed even to memorize effectively, people must build a mental representation that imposes order and coherence on experience and information... . . . Early on, however, cognitive scientists found that they could not account for problem solving and learning without attending to what people already *knew* (*italics* in the original). Vast knowledge of possible positions in a chess game, they found – not a superior ability to 'think ahead' – was what distinguished chess masters from merely good chess players. In every field of thought, cognitive scientists found that knowledge is essential to thinking and acquiring new knowledge - in other words to learning. . . These repeated findings about the centrality of knowledge in learning make perfect sense for a constructivist theory of learning, because one has to have something with which to construct. . . .they insist that knowledge - *correct* knowledge (*italics* in the original) - is essential at every point in learning. And they make it impossible to suggest that education for the information age should not trouble itself with facts and information, but only with processes of learning and thinking. What we know now is that just facts alone do not constitute true knowledge and thinking power, so thinking processes cannot proceed without something to think about. Knowledge is in again, but alongside thinking, indeed, intertwined with it, not instead of thinking. So although it is essential for children to have the experience of discovering and inventing, their experience must be of one of disciplined invention, that is, by established processes of reasoning and logic. [The above advocated] *Knowledge-based Constructivism*, taken seriously, *points to a position that can moderate the century-long polarity between passive drill pedagogies and child-centered discovery pedagogies.*" [Our *italics*.]

#CE \*Steffe, L., & J. Gale, eds. 1995. *Constructivism in Education*. Lawrence Erlbaum. Amazon.com information at <<http://tinyurl.com/33gph7>>; a "book preview" is online at <<http://tinyurl.com/2p48wx>>.

According to the preface the core paradigms discussed in this book are "social constructivism, radical constructivism, social constructionism, information processing constructivism, cybernetic systems, and sociocultural approaches to mediated action." [Our *italics*.]

#CE \*Taber, K.S. 2006. "Constructivism's New Clothes: The Trivial, the Contingent, and a Progressive Research Programme into the Learning of Science," *Foundations of Chemistry* 8(2): 1572-8463; in a special issue "Constructivism in Chemical Education," online to subscribers at <<http://tinyurl.com/2nd9cc>>. An abstract of Tabor's article is online at <<http://tinyurl.com/2kcmye>>.

#CS \*Wilson, K.G. & C.K. Barsky. 2001. "From Social Construction to Questions for Research: The Promise of the Sociology of Science," Chapter 11 in Larbinger & Collins (2001).

#CS \*Wilson, K.G. & C.K. Barsky. 2001. "Beyond Social Construction," Chapter 34 in Larbinger & Collins (2001).

## **C. Drivers of Education Reform and Gender Equity: Economic Competitiveness and Preservation of Life on Planet Earth #EC #LPE**

### ***C1. Economic Competitiveness***

#EC \*Brakke, D.F. 2006. "Science, Technology and the Global Economy: The 'Augustine' report and others appeal for attention as quickly as possible to expanding the pipeline of students in scientific and technological fields," *AWIS Magazine*, Winter; online at <<http://www.awis.org/pubs/magazine/35-1/communicatingScience.pdf>> (224 kB). The "Augustine report" is more commonly known as "Rising Above the Gathering Storm" [NAP (2007)]. Brakke wrote:

"A number of recent reports call America to action to address issues related to the nation's scientific and technological enterprise. These reports have come from the Business Roundtable, the National Academies, the Council on Competitiveness, and the Business and Higher Education forum, among others. They focus on the relationship between the scientific and technological developments, creativity, and innovation essential to American competitiveness in the future. This convergence of attention from a wide range of groups coming to very similar conclusions is already leading to bills being introduced in the U.S. Senate and attention by the House Science Committee. Perhaps the most important of the reports, and certainly the most comprehensive, is the one issued by The National Academies, 'Rising Above the Gathering Storm' or sometimes referred to as the 'Augustine Report.' "

#EC #IC \*DeHaan, R.L. & K.M. Venkat Narayani, eds. 2008. *Education For Innovation Implications For India, China And America*. Sense, publisher's information at <<http://tinyurl.com/3l5jdb>>. The publisher writes (our *italics*):

"In *Education for Innovation: Implications for India, China and America*, distinguished thought leaders explore cutting-edge questions such as: Can inventiveness and ingenuity be taught and nurtured in schools and colleges? What are the most effective educational strategies to promote these abilities? How are vibrant economies driven by innovation? *What is the relationship between education for innovation and national competitiveness or economic development?* Focusing on the Worlds' three most populous countries and largest economies, this book provides a forum for international experts to address a range of critically important issues related to higher education and its role in creating innovative societies."

A free preview of pages 1-19 is online at

<<http://www.sensepublishers.com/catalog/files/9789087900731.pdf>> (668 kB)

#EC George, Y.S., D.S. Neale, V. Van Horne, and S.M. Malcom. 2001. *In Pursuit of a Diverse Science, Technology, Engineering, and Mathematics Workforce: Recommended Research Priorities to Enhance Participation by Underrepresented Minorities*. American Association for the Advancement of Science, online at

<[http://ehrweb.aaas.org/mge/Reports/Report1/AGEP/AGEP\\_report.pdf](http://ehrweb.aaas.org/mge/Reports/Report1/AGEP/AGEP_report.pdf)> (3.7 MB). From the Introduction (our *italics*):

*“Building a diverse workforce in science, technology, engineering and mathematics (STEM) is increasingly important to sustaining the nation’s productivity and economic strength.* Evidence already exists that the lack of United States citizens in the STEM workforce is limiting economic growth, and business has looked to H-1B Visas (guest workers) as a way to fill this gap. However, recognizing the connection between sustained economic growth. . .[our insert - is “sustainable growth” an oxymoron? See Bartlett (1998)]. . . . and a technically trained workforce, other nations are aggressively restructuring higher education and workforce policies to keep their nationals at home.”

#EC \*Gordon, B. 2007. “U.S. Competitiveness: The Education Imperative,’ *Issues in Science and Technology*, Spring, online at <<http://www.issues.org/23.3/gordon.html>>. Gordon wrote:

“Because the foundation for future success is a well-educated workforce, the necessary first step in any competitiveness agenda is to improve science and mathematics education.”

Bart Gordon (D-TN) chairs the Science and Technology Committee of the U.S. House of Representatives.

Responses by Leon Lederman and Camilla Benbow are at

<<http://www.issues.org/23.4/forum.html>> [Scroll down to “Education and U.S. competitiveness.”] Lederman wrote:

“U.S. post–World War II prosperity emerged from a huge investment (the G.I. Bill) in our human resources and a strong and continuing contribution from immigration. For decades, some 60% of our graduate schools were occupied by immigrants. About half of these students returned home and half stayed to contribute to a vibrant S&T workforce. However, as anticipated by Alan Greenspan, over time and for a variety of reasons, our educational system began to fail and our immigration began to decline. Today, we are witnessing the results of this double whammy. Our primary-school teachers are emerging from teachers’ colleges as ignorant as ever of math and science. U.S. students begin to turn off in early grades. Our middle- and high-school curricula are out of the 19th century, and the ‘system’ of 50 states, 15,000 school boards, 25,000 high schools, teachers’ unions, PTAs, and textbook publishers, and the wide diversity of public school education, all provide an awesome challenge. We need not to fine-tune around the edges but to transform this impossible system.”

Amazon.com (probably illegally) hawks the free online responses of Lederman & Benbow for \$9.95 at <<http://tinyurl.com/3j69fe>>.

#EC Hewlett, S.A., C.B. Luce, L.J. Servon, L. Sherbin, P. Shiller, E. Sosnovich, & K. Sumberg. 2008. *"The Athena Factor: Reversing the Brain Drain in Science, Engineering and Technology,"* Harvard Business Review Research Report, publisher's information at <<http://app.post.hbsp.harvard.edu/athena/athena13/landingpage1.html>>. The highlights are:  
a. 41% Science, Engineering, and Technology (SET) professionals are female at career lower-rungs,  
b. 52% quit SET jobs, peaking at 10 year career mark,  
c. 5 major factors contribute to mid-career SET female attrition,  
d. 13 companies share initiatives designed to keep women on track with SET careers,  
e. 25% reduction in female attrition adds 220,000 to qualified SET labor pool.  
Center for Work-Life Policy <<http://www.worklifepolicy.org/>> press release at <<http://www.worklifepolicy.org/documents/AthenaPressRelease-April30.pdf>> (40 kB) and abstract at <[http://www.worklifepolicy.org/index.php/section/research\\_pubs](http://www.worklifepolicy.org/index.php/section/research_pubs)>.

#EC \*Lowell, B.L. & H. Salzman. 2007. "Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality, and Workforce Demand," Urban Institute; online at <<http://www.urban.org/url.cfm?ID=411562>>. The full paper is at <[http://www.urban.org/UploadedPDF/411562\\_Salzman\\_Science.pdf](http://www.urban.org/UploadedPDF/411562_Salzman_Science.pdf)> (184 kB). The first two paragraphs of the abstract are:

"Several high-level committees have concluded that current domestic and global trends are threatening America's global science and engineering (S&E) preeminence. Of the challenges discussed, few are thought to be as serious as the purported decline in the supply of high quality students from the beginning to the end of the S&E pipeline—a decline brought about by declining emphasis on math and science education, coupled with a supposed declining interest among domestic students in S&E careers.

However, our review of the data fails to find support for those presumptions. Rather, the available data indicate *increases* in the absolute numbers of secondary school graduates and *increases* in their math and science performance levels. Domestic and international trends suggest that that U.S. schools show steady improvement in math and science, the U.S. is not at any particular disadvantage compared with most nations, and the supply of S&E-qualified graduates is large and ranks among the best internationally. Further, the number of undergraduates completing S&E studies has grown, and the number of S&E graduates remains high by historical standards. Why, then, is there a purported failure to meet the demand for S&E college students and S&E workers?"

Somehow similar arguments were made in *The Manufactured Crisis* [Berliner & Biddle (1996)]. We do not think the arguments of Berliner & Biddle (1996) and Lowell and Salzman (2007) diminish the crucial need to increase the science/math literacy of the general population so as to increase the probability of survival of life on planet Earth - see Part 2, Section C2: "Preservation of Life on Planet Earth."

#EC NAP. 2007a. National Academy Press, Committee on Maximizing the Potential of Women in Academic Science and Engineering, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, *Beyond Bias and Barriers: Fulfilling the Women in Academic Science and Engineering*, online at <<http://www.nap.edu/catalog/11741.html>> :

“The United States economy relies on the productivity, entrepreneurship, and creativity of its people. *To maintain its scientific and engineering leadership amid increasing economic and educational globalization, the United States must aggressively pursue the innovative capacity of all its people—women and men.* [Our italics.] However, women face barriers to success in every field of science and engineering; obstacles that deprive the country of an important source of talent. Without a transformation of academic institutions to tackle such barriers, the future vitality of the U.S. research base and economy are in jeopardy. *Beyond Bias and Barriers* explains that eliminating gender bias in academia requires immediate overarching reform, including decisive action by university administrators, professional societies, federal funding agencies and foundations, government agencies, and Congress. If implemented and coordinated across public, private, and government sectors, the recommended actions will help to improve workplace environments for all employees *while strengthening the foundations of America’s competitiveness.*”[Our italics.]

#EC \*NAP. 2007b. Committee on Science, Engineering, and Public Policy, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future,*” National Academies Press; online at <<http://books.nap.edu/catalog/11463.html>> :

“In a world where advanced knowledge is widespread and low-cost labor is readily available, U.S. advantages in the marketplace and in science and technology have begun to erode. A comprehensive and coordinated federal effort is urgently needed to bolster U.S. competitiveness and pre-eminence in these areas. This congressionally requested report by a pre-eminent committee makes four recommendations along with 20 implementation actions that federal policy-makers should take to create high-quality jobs and focus new science and technology efforts on meeting the nation's needs, especially in the area of clean, affordable energy: 1) Increase America's talent pool by vastly improving K-12 mathematics and science education; 2) Sustain and strengthen the nation's commitment to long-term basic research; 3) Develop, recruit, and retain top students, scientists, and engineers from both the U.S. and abroad; and 4) Ensure that the United States is the premier place in the world for innovation. Some actions will involve changing existing laws, while others will require financial support that would come from reallocating existing budgets or increasing them. *Rising Above the Gathering Storm* will be of great interest to federal and state government agencies, educators and schools, public decision makers, research sponsors, regulatory analysts, and scholars.

But should economic competitiveness be the *primary* imperative for education reform as stressed in the above report and reiterated by Brakke (2006) and Gordon (2007)? As indicated in “Can Scientific Research Enhance the Art of Teaching?” [Hake (2007f)]:

“Although international competitiveness is often cited by educational leaders, politicians, and business executives, more crucial in my view is the need to overcome the monumental problems now *threatening life on planet Earth.*”

#EC NSB. 2006a. National Science Board, *Science and Engineering Indicators 2006*, online at <<http://nsf.gov/statistics/seind06>> and <<http://nsf.gov/statistics/seind06/pdfstart.htm>>.

In Chapter 2 “Higher Education in Science and Engineering” at <<http://www.nsf.gov/statistics/seind06/c2/c2s4.htm>> the NSB states:

“In 2003, women earned 39% of S&E doctoral degrees awarded in the United States. The percentage of S&E doctoral degrees earned by women in other countries and areas of the world varied widely. In Western Europe, the percentages earned by women varied from 27% in Germany to 45% in Italy. In Asia, women earned roughly one-fifth of all S&E doctoral degrees.”

In Chapter 4, “Research and Development: Funds and Technology Linkages” at

<<http://www.nsf.gov/statistics/seind06/c4/c4s6.htm>> it is stated:

“Increasingly, *the international competitiveness of a modern economy is defined by its ability to generate, absorb, and commercialize knowledge.* [Our *italics*.] Although it is no panacea, scientific and technological knowledge has proven valuable in addressing the challenges countries face in a variety of areas such as sustainable development, . . . [our insert - in contrast to “sustainable growth,” “sustainable development” is not necessarily an oxymoron – see Bartlett (1998) and Daly (1996)]. . . economic growth, health care, and agricultural production. Nations benefit from R&D performed abroad, but domestic R&D performance is an important indicator of a nation's innovative capacity and its prospects for future growth, productivity, and S&T competitiveness. This section compares international R&D spending patterns. Topics include absolute expenditure trends, measures of R&D intensity, the structure and focus of R&D performance and funding across sectors, and government research-related priorities and policies.”

#EC NSB. 2006b. National Science Board, *America’s Pressing Challenge – Building A Stronger Foundation: A Companion to Science and Engineering Indicators 2006*; online at

<<http://www.nsf.gov/statistics/nsb0602/nsb0602.pdf>>. On page 6 the NSB wrote (our *italics*) : “*America’s competitive edge in this ‘flat world,’ its strength and versatility, all depend on an educational system capable of producing young people and productive citizens who are well prepared in science and mathematics.* We know – and this report demonstrates – that there is a need to make drastic changes within the Nation’s science and mathematics classrooms. If not, our Nation risks raising generations of students and citizens who do not know how to think critically and make informed decisions based on technical and scientific information. Nor will they have a firm grasp of academic language necessary to advance into STEM careers and produce the innovation and discovery necessary to maintain our Nation’s prosperity for the future.”

#EC NSB. 2008. National Science Board. *Science and Engineering Indicators 2008*, online as Volume 1 (9.5 MB pdf ) and Volume 2: Appendix Tables (2.7 MB) at <<http://www.nsf.gov/statistics/seind08/pdfstart.htm>>.

In Chapter 2 “Higher Education in Science and Engineering”

<<http://www.nsf.gov/statistics/seind08/pdf/c02.pdf>> (296 kB) it is stated:

“Among U.S. citizens, the proportion of S&E doctoral degrees earned by women has risen considerably in the past two decades, reaching a record high of 46% in 2005 (appendix table 2-31). During this period, women made gains in all major fields. However, as figure 2-21 shows, considerable differences by field continue. Women earn half or more of doctorates in non-S&E fields, in social/behavioral sciences, and in life sciences, but they earn considerably less than half of doctorates in physical sciences (29%), math/computer sciences (24%), and engineering (20%) (appendix table 2-31). Although the percentages of degrees earned by women in these fields is low, they are substantially higher than was the case in 1985 (16%, 17%, and 9%, respectively).”

In the Overview at <<http://www.nsf.gov/statistics/seind08/c0/c0s4.htm>> it is stated:

“The progressive shift toward more knowledge-intensive economies around the world is dependent upon the availability and continued inflow of individuals with postsecondary training to the workforce. The expansion of higher education systems in many countries that started in the 1970s and continues today has enabled this shift to occur. Such broadening of higher education availability and access in many cases entailed greater relative emphasis than in the United States on education and training in engineering, natural sciences, and mathematics. Demographic structures, stable or shrinking populations, expanding opportunities in other fields, and *declining interest in mathematics and science among the young are viewed by governments of many mature industrial countries as a potential threat to the sustained competitiveness of their economies*. The topic has assumed increasing urgency in meetings of ministers of OECD member countries. [Our *italics*.]

#EC O'Brien, M. 2008. *Human Resource Executive Online*, 27 May, “Analyzing Female Brain Drain”; online at

<<http://www.hreonline.com/HRE/story.jsp?storyId=96768436>>. The abstract reads [our inserts at “. . .[insert]. . .”]

“Dueling reports on women in the sciences offer contrasting opinions on reasons for the scarcity of women in such industries. One report. . . [Hewlett et al. (2008)]. . . urges HR leaders to address issues of sexual harassment, isolation and the scarcity of mentors, while two others. . [Rosenbloom *et al.* (2008) & Benbow & Lubinski (2008)]. . . conclude that women simply prefer jobs where they can interact with people, such as medicine.”

#EC OSTP. 2000. Office of Science Technology and Policy, *Ensuring a Strong U.S. Scientific, Technical, and Engineering Workforce in the 21st Century*, online as a 121 kB pdf at <[http://clinton4.nara.gov/WH/EOP/OSTP/html/00411\\_3.html](http://clinton4.nara.gov/WH/EOP/OSTP/html/00411_3.html)> (our *italics*):

“Our nation’s *international competitiveness* and national well-being have long depended on a highly skilled ST&E workforce. Recent studies have shown that science and technology have generated about half the productivity growth the United States has enjoyed over the past 50 years; created millions of high-skill, high-wage jobs; and improved the quality of life in America. Those productivity increases must continue in the 21st century if our high standard of living is to be maintained or improved. . . . .

In 1996, women earned almost half (47 percent) of the S&E bachelor's degrees but only 38 percent of the master's degrees and *32 percent of the doctorates*. The latter statistic is particularly significant, because it is the Ph.D. degree that enables women to join university faculties and serve as role models for female students who will become part of the future ST&E workforce. While participation of women has increased significantly over the past two decades, further improvement is needed. The percentage of women in science, technology and engineering varies greatly from field to field. Women earned 38 percent of all science and engineering master's degrees awarded in 1996. This included 53 percent of those in biological science, but only 17 percent of those in engineering. In 1996, women earned 51 percent of the doctorates in the social and behavioral sciences and 42 percent in biology, but only 12 percent in engineering, 15 percent in computer sciences, and 21 percent in mathematics. *Thus women's relative percentages are low in some fields that have rapidly increasing demands for highly skilled workers and are important for economic growth.*

## **C2. Preservation of Life on Planet Earth**

#LPE \*Bartlett, A.A. 1998. "Reflections on Sustainability, Population Growth, and the Environment – Revisited," online at <<http://www.una-colorado.org/mod/forum/discuss.php?d=83>>. A revised version (January 1998) ) of a paper that was first published in *Population & Environment* **16**(1): 5-35, September 1994. Bartlett wrote:

"When applied to material things, the term 'sustainable growth' is an oxymoron. (One can have sustainable growth of non-material things such as inflation.) Daly (1994). . .[our insert – a more recent edition is Daly (1996)]. . . has pointed out that 'sustainable development' may be possible if materials are recycled to the maximum degree possible, and if one does not have growth in the annual material throughput of the economy."

#LPE \*Bartlett, A.A. , edited by R.G. Fuller, V.P. Clark, & J.A. Rogers. 2004. *The Essential Exponential! For the Future of Our Planet*. Center for Science, Mathematics, and Computer Education, Univ. of Nebraska - Lincoln <<http://scimath.unl.edu/csmce/exp.php>> :

"The greatest shortcoming of the human race is our inability to understand the exponential function."  
A.A. Bartlett

#LPE \*Bartlett, A.A. 2004. "Thoughts on Long-Term Energy Supplies: Scientists and the Silent Lie: The world's population continues to grow - shouldn't physicists care?" *Physics Today* **57**(7); 53-55; online at <[http://fire.pppl.gov/energy\\_population\\_pt\\_0704.pdf](http://fire.pppl.gov/energy_population_pt_0704.pdf)>. See also (a) the companion *Physics Today* article by Paul Weisz (2004); (b) the ensuing criticism of the views of Bartlett and Weiss (and counters by those authors) in the Letters section of *Physics Today* **57**(11): 12-20, online to all at <[http://scitation.aip.org/journals/doc/PHTOAD-ft/vol\\_57/iss\\_11/12\\_1.shtml](http://scitation.aip.org/journals/doc/PHTOAD-ft/vol_57/iss_11/12_1.shtml)>; (c) Bartlett (2006). Bartlett (2004) wrote:

"The most sacred icon in the 'religion' of the US economic scene is steady growth of the gross national product, enterprises, sales, and profits. Many people believe that such economic growth requires steady population growth. Although physicists address the problems that result from a ballooning population—such as energy shortages, congestion, pollution, and dwindling resources—their solutions are starkly deficient. Often, they fail to recognize that the solutions must involve stopping population growth."

#LPE \*Bartlett, A.A. 2006. "Scientific American and the Silent Lie," *Phys. Teach.* **44**(9): 623-624; online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=PHTEAH&Volume=44&Issue=9>>.

#LPE \*Brown, L.R. 2008. *Plan B 3.0, Mobilizing to Save Civilization*. W.W. Norton, 3rd edition. We thank Marc Sabb for calling our attention to this book. Amazon.com information at <<http://tinyurl.com/6kgnb0>>:

“In this updated edition of the landmark Plan B, Lester Brown outlines a survival strategy for our early twenty-first-century civilization. The world faces many environmental trends of disruption and decline, including rising temperatures and spreading water shortage. In addition to these looming threats, we face the peaking of oil, annual population growth of 70 million, a widening global economic divide, and a growing list of failing states. The scale and complexity of issues facing our fast-forward world have no precedent.

With Plan A, business as usual, we have neglected these issues overly long. In *Plan B 3.0*, Lester R. Brown warns that the only effective response now is a World War II-type mobilization like that in the United States after the attack on Pearl Harbor.”

About the Author: Lester R. Brown, president of the Earth Policy Institute. . . . . [<http://www.earth-policy.org/>]. . . . , is one of the world's most widely published authors, with books in more than forty languages. A MacArthur Fellow, he lives in Washington, DC.”

#LPE \*Daly, H.E. 1996. *Beyond Growth: The Economics of Sustainable Development*. Beacon Press, publishers information at <<http://www.beacon.org/productdetails.cfm?PC=1384>>. A Google “book preview” is online at <<http://tinyurl.com/3nfs4v>>.

#LPE \*Duderstadt, J.J. 2000. *A University for the 21st Century*. Univ. of Michigan Press; for a description see <<http://tinyurl.com/9lhpl>>. On pages 20-21 Duderstadt wrote :

SPACESHIP EARTH: There is mounting evidence that the growing population and invasive activities of humankind are now altering the fragile balance of our planet. The concerns are both multiplying in number and intensifying in severity: the destruction of forests, wetlands and other natural habitats by human activities leading to extinction of millions of biological species and the loss of biodiversity; the buildup of greenhouse gases such as carbon dioxide and their possible impact on global climates; the pollution of our air, water, and land.

With the world population now at 6 billion, we are already consuming 40% of the world's photosynthetic energy production. Current estimates place a stable world population at about 8 to 10 billion by the late twenty-first century, assuming fertility rates continue to drop over the next several decades. Yet even at this reduced rate of population growth, we could eventually consume all of the planet's resources, unless we take action. *Because of this overload of the world's resources, even today, over 1.2 billion of the world's population live below the subsistence level, and 500 million below the minimum caloric intake level necessary for life.* [Our italics.]

It could well be that coming to grips with the impact of our species on our planet, learning to live in a sustainable fashion on spaceship earth, will become the greatest challenge of our generation. This will be particularly difficult for a society that has difficulty looking more than a generation ahead encumbered by a political process that generally functions on an election-by-election basis, as the current debate over global change makes all too apparent. *Universities must take the lead in developing knowledge and educating the world's citizens to allow us to live upon our planet while protecting it.* [Our italics.]

#LPE \*Hake, R.R. 2000c. "The General Population's Ignorance of Science Related Societal Issues: A Challenge for the University," *AAPT Announcer* 30(2): 105; online at <<http://www.physics.indiana.edu/~hake/GuelphSocietyG.pdf>> (2.1 MB).

Based on an earlier libretto with the leitmotiv: "The road to U.S. science literacy begins with effective university science courses for pre-college teachers." The opera dramatizes the fact that the failure of universities *throughout the universe* to properly educate pre-college teachers is responsible for our failure to observe any signs of extraterrestrial (and even terrestrial) intelligence.

#LPE #IE \*Hake, R.R. 2007f. "Can Scientific Research Enhance the Art of Teaching?" invited talk, AAPT Greensboro meeting, 31 July, online at <<http://www.physics.indiana.edu/~hake/Sci&Art3.pdf>> (1.2 MB), and as ref. 50 at <<http://www.physics.indiana.edu/~hake/>>.

#LPE \*Intergovernmental Panel on Climate Change (IPPC). 2008. Online at <<http://www.ipcc.ch/>>; see especially IPCC Fourth Assessment Report, Working Group I Report "The Physical Science Basis" <<http://www.ipcc.ch/ipccreports/ar4-wg1.htm>>.

#LPE \*Makhijani, A. 2007. *Carbon-Free and Nuclear-Free: A Roadmap for US Energy Policy*. Ieer Press. Online as a 4.4 MB pdf at <<http://www.ieer.org/carbonfree/index.html>>. We thank Hugh Haskell for calling our attention to this book. EggheadBooks information at <<http://www.eggheadbooks.org/books/carbonfree.htm>>:

"In a world confronting global climate change, political turmoil among oil exporting nations, nuclear weapons proliferation, nuclear plant safety and waste disposal issues, the United States must assume a leadership role in moving to a zero-CO<sub>2</sub>-emissions energy economy. At the same time, the U.S. needs to take the lead in reducing the world's reliance on nuclear power. This breakthrough joint study by the Institute for Energy and Environmental Research and the Nuclear Policy Research Institute shows how our energy needs can be met by alternative sources. Wind, solar, biomass, microalgae, geothermal and wave power are all part of the solution. *Carbon-Free and Nuclear-Free* is must reading for people concerned with energy politics and everyone who wants to take action to protect the planet's future."

Amazon.com information at <<http://tinyurl.com/3l6jd6>>.

A good review by John Roeder, soon to be on the *Teachers Clearinghouse for Science and Socioety Education Newsletter* <<http://www.physics.rutgers.edu/~lindenf/pse/>> can be download at <<http://tinyurl.com/4ba8el>> - scroll to the bottom and click on <Reviews(W08).doc>.

#LPE \*McKibben, B. 2006. *The End of Nature*. Random House. Amazon.com information at <<http://tinyurl.com/6k7fum>>:

"Whatever we once thought Nature was--wildness, God, a simple place free from human thumbprints, or an intricate machinery sustaining life on Earth--we have now given it a kick that will change it forever. Humanity has stepped across a threshold. In his free-ranging and provocative book, Bill McKibben explores the philosophies and technologies that have brought us here, and he shows how final a crossing we have made." -- James Gleick, author of *Chaos*

#LPE \*McKibben, B. 2008a. "Civilization's last chance: The planet is at a tipping point on climate change, and it gets much worse, fast," *Los Angeles Times*, 11 May; online at <<http://www.latimes.com/news/opinion/la-op-mckibben11-2008may11,0,7434369.story>>.

McKibben wrote:

"....all of a sudden, those grim Club of Rome types who, way back in the 1970s, went on and on about the "limits to growth" suddenly seem ... how best to put it, RIGHT (emphasis in the original).

All of a sudden it isn't morning in America, it's dusk on planet Earth.

There's a number -- a new number -- that makes point most powerfully. It may now be the most important number on Earth: 350. As in parts per million of carbon dioxide in the atmosphere.

A few weeks ago, NASA's chief climatologist, James Hansen, submitted a paper to *Science* magazine with several coauthors. The abstract attached to it argued -- and I have never read stronger language in a scientific paper -- that "*if humanity wishes to preserve a planet similar to that on which civilization developed and to which life on earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO<sub>2</sub> will need to be reduced from its current 385 ppm to at most 350 ppm.*" [Our *italics*.]

See also McKibben's website <<http://www.350.org/4/>>.

#LPE \*McKibben, B. 2008b. *Deep Economy: The Wealth of Communities and the Durable Future*. Holt Paperbacks. We thank Art Hobson, list manager of PHYSOC <<http://listserv.uark.edu/archives/physoc.html>>, for calling our attention to this book. Amazon.com information at <<http://tinyurl.com/5yt7m4>>:

"Beginning with his prescient treatise on global warming, *The End of Nature* (1990), McKibben has been investigating and elucidating some of the most confounding aspects of our lives. He now brings his signature clarity of thought and handsomely crafted prose to a pivotal, complicated subject, the negative consequences of our growth-oriented economy. McKibben incisively interprets a staggering array of studies that document the symbiotic relationship between fossil fuels and five decades of dizzying economic growth, and the many ways the pursuit of ever-higher corporate profits has led to environmental havoc and neglect of people's most basic needs. At once reportorial, philosophic, and anecdotal, McKibben, intoning the mantra 'more is not better,' takes measure of diminishing returns. With eroding security, a dysfunctional health system, floundering public schools, higher rates of depression, 'wild inequity' in the distribution of wealth, and damage to the biosphere, McKibben believes a new paradigm is needed, that of a 'deep economy' born of sustainable and sustaining communities anchored in local resources. Using the farmer's market as a template, he explains the logistics of workable alternatives to the corporate imperative based on ecological capacities and the 'economics of neighborliness.' With the threat of energy crises and global warming, McKibben's vision of nurturing communities rooted in traditional values and driven by 'green' technologies, however utopian, may provide ideas for constructive change."

– Donna Seaman, American Library Association.

#LPE \*Nelson, C.E. 2006. "Celebration and Reflection," *MountainRise* 3(1), online at <<http://mountainrise.wcu.edu/archive/vol3no1/html/nelson.html>>. Nelson concludes: "For a variety of reasons, it is becoming much clearer that major real world problems are collectively worse than most faculty have previously realized. These include global climatic change, social inequity, national and international disease situations and geopolitical problems. Public discourse in a nation's capital on these issues can be seen as a collective final exam for the institutions of higher education in that country. Most of the major players in the national government, at least in the US, have an undergraduate degree and many have a graduate or professional degree. *But policies and public discourse rarely seem to adequately grasp the complexities and tradeoffs.* [Our *italics*.] Perhaps I am being too optimistic in suggesting that more than a few faculty see SOTL . . . .[Scholarship of Teaching and Learning]. . . . as a way of focusing higher education on finding more effective ways to foster fundamental outcomes like critical thinking, engagement with the real world and sophisticated ethical judgment. I, for one, certainly hope that the effects of SOTL will extend this far."

#LPE \*RealClimate. 2008. "Climate science for climate scientists," online at <<http://www.realclimate.org/>> and <<http://www.realclimate.org/index.php/archives/2007/05/start-here/>>.

#LPE Romer, R.H. 1988. "Editorial: 958 men, 93 women – How many Lise Meitners among those 865?" *Am. J. Phys.* 56(10): 873; online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=56&Issue=10>>. See also the valuable response by Button-Shafer (1990) in Part 1. Pertinent to Part 2, Section C2 of this tract, one might also ask "*How many Rachel Carsons are among them?*" – see <<http://www.rachelcarson.org/>>.

#LPE \*Speth, J.G. 2008. *The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability*. Yale University Press, publisher's information at <<http://yalepress.yale.edu/yupbooks/book.asp?isbn=978030013611>>:

“How serious are the threats to our environment? Here is one measure of the problem: if we continue to do exactly what we are doing, with *no* growth in the human population or the world economy, the world in the latter part of this century will be unfit to live in. Of course human activities are not holding at current levels—they are accelerating, dramatically—and so, too, is the pace of climate disruption, biotic impoverishment, and toxification. In this book Gus Speth, author of *Red Sky at Morning* and a widely respected environmentalist, begins with the observation that the environmental community has grown in strength and sophistication, but the environment has continued to decline, to the point that we are now at the edge of catastrophe.

Speth contends that this situation is a severe indictment of the economic and political system we call modern capitalism. Our vital task is now to change the operating instructions for today’s destructive world economy before it is too late. The book is about how to do that.”

See also Speth’s website <<http://www.thebridgeattheedgeoftheworld.com/>>:

“My point of departure in this book is the momentous environmental challenge we face. But today’s environmental reality is linked powerfully with other realities, including growing social inequality and neglect and the erosion of democratic governance and popular control... As citizens we must now mobilize our spiritual and political resources for transformative change on all three fronts.” – Gus Speth

“When a figure as eminent and mainstream as Gus Speth issues a warning this strong and profound, the world should take real notice. This is an eloquent, accurate, and no-holds-barred brief for change large enough to matter.” – Bill McKibben

Amazon.com information at <<http://tinyurl.com/5v6m4w>> - includes many editorial reviews.

#LPE \*Union of Concerned Scientists. 2008. Online at <<http://www.ucsusa.org/>>. See especially “Global Warming” at <[http://www.ucsusa.org/global\\_warming/science/](http://www.ucsusa.org/global_warming/science/)>:

“Global warming is already under way. The evidence is vast and the urgency of taking action becomes clearer with every new scientific study. Some of the most obvious signs are visible in the Arctic, where rising temperatures and melting ice are dramatically changing the region’s unique landscapes and wildlife—as well as people’s lives and livelihoods. Across the globe, other early warning signs include melting glaciers, shifting ranges of plants and animals, and the earlier onset of spring.”

#LPE \*Weiss, P.B. 2004. “Basic Choices and Constraints on Long-Term Energy Supplies,” *Physics Today* 57(7); 47-52; online at <[http://fire.pppl.gov/energy\\_choices\\_pt\\_0704.pdf](http://fire.pppl.gov/energy_choices_pt_0704.pdf)> 896 kB):

“Population growth and energy demand are exhausting the world’s fossil energy supplies, some on the timescale of a single human lifespan. Increasingly, sharing natural resources will require close international cooperation, peace, and security. . . . [our insert - and the help of women in science/math]. . . .”

#LPE \*Wilson. E.O. 1998. *Consilience: The Unity of Knowledge*. Knopf. Amazon.com information at <<http://www.amazon.com/Consilience-Knowledge-Edward-O-Wilson/dp/067976867X>>. Note the “Search Inside” feature. Wilson wrote:

“The global population is precariously large, and will become much more so before peaking some time after 2050. Humanity overall is improving per capita production, health, and longevity. But it is doing so by eating up the planet's capital, including natural resources and biological diversity millions of years old. *Homo sapiens* is approaching the limit of its food and water supply. Unlike any species before, it is also changing the world's atmosphere and climate, lowering and polluting water tables, shrinking forests, and spreading deserts. Most of the stress originates directly or indirectly from a handful of industrialized countries. Their proven formulas for prosperity are being eagerly adopted by the rest of the world. The emulation cannot be sustained, not with the same levels of consumption and waste. Even if the industrialization of the developing countries is only partially successful, the environmental aftershock will dwarf the population explosion that preceded it.”

#LPE \*Wilson. E.O. 2003. *The Future of Life*. Random House, publisher's information at <<http://www.randomhouse.com/catalog/display.pperl?isbn=978067976811>>:

“One of the world's most important scientists, Edward O. Wilson is also an abundantly talented writer who has twice won the Pulitzer Prize. In this, his most personal and timely book to date, he assesses the precarious state of our environment, examining the mass extinctions occurring in our time and the natural treasures we are about to lose forever. Yet, rather than eschewing doomsday prophesies, he spells out a specific plan to save our world while there is still time. His vision is a hopeful one, as economically sound as it is environmentally necessary. Eloquent, practical and wise, this book should be read and studied by anyone concerned with the fate of the natural world.”

## D. Education and the Brain #EB

#EB \*Anderson, J.R. 2004. *Cognitive Psychology and Its Implications*. Worth, 6th ed., publisher's information at <<http://tinyurl.com/6c64a2>> :

“Anderson offers systematic and accessible presentation of the theoretical foundations of higher mental processes, with each important idea made concrete by specific examples and experiments. Focusing on knowledge representation as the central issue of cognition research, the book emphasizes an information processing approach to the field, but *offers thorough coverage of the cognitive neuroscience approach as well (extensively updated for this edition)*. [Our *italics*.] The Sixth Edition also features a new two-color design and an expanded art program, with new figures highlighting areas of the brain most closely associated with specific cognitive functions. The result is a lucid, integrated view of the current state of a dynamic field, from one of its most accomplished practitioners.”

Redish (2006) writes: “Take a look at John Anderson's standard text on cognitive science and compare the 4th, 5th, and 6th editions. The 4th has little mention of neuroscience. The 5th has some. The 6th has a picture of the brain on the inside front cover and is filled with neuroscience.”

#EB #SDMA Baron-Cohen, S. 2004. *The Essential Difference: Male And Female Brains And The Truth About Autism*. Basic Books. Amazon.com information at <<http://tinyurl.com/5fp5ll>>. Note the “Search Inside” feature.

“FROM PUBLISHERS WEEKLY: Should the title fail to express Baron-Cohen's certainty about gender differences, the Cambridge Univ. professor of psychology and psychiatry lays out his controversial thesis on page one: ‘The female brain is predominantly hard-wired for empathy. The male brain is predominantly hard-wired for understanding and building systems.’ Defending this bold view is a tough but engaging battle, one that's alleviated by Baron-Cohen's disclaimer that his conclusions refer to statistical majorities rather than ‘all men’ and ‘all women,’ but exacerbated by his habit of simultaneously skirting and employing gender stereotypes. His copious evidence ranges from the anecdotal to the anthropological, and from the neurological to the case study (the author and his research team conducted many of these studies).”

#EB \*Bransford, J.D., A.L. Brown, R.R. Cocking, eds. 2000. *How people learn: brain, mind, experience, and school*. Nat. Acad. Press; online at <<http://tinyurl.com/apbgf>>. See also *How People Learn: Bridging Research and Practice* [NAP (1999)].

The quote in Hake (2007j) is from page 106 of the earlier edition, i.e., Bransford *et al.* (1999).

See also *How People Learn: Bridging Research and Practice* [NAP (1999)].

#EB \*Bruer, J.T. 1997. “Education and the Brain: A Bridge Too Far,” *Educational Researcher* 26(8): 4-16, online at <[http://www.jsmf.org/about/j/education\\_and\\_brain-smaller.pdf](http://www.jsmf.org/about/j/education_and_brain-smaller.pdf)> (4.5 MB).

#EB \*Bruer, J.T. 2006. “Points of View: On the Implications of Neuroscience Research for Science Teaching and Learning: Are There Any? A Skeptical Theme and Variations: The Primacy of Psychology in the Science of Learning,” *CBE-Life Sciences Education* 5: 104 -110; online at <<http://www.lifescied.org/cgi/reprint/5/2/104>>. See also Bruer (1997).

**#EB** Cahill, L. 2005. "His Brain, Her Brain: It turns out that male and female brains differ quite a bit in architecture and activity. Research into these variations could lead to sex-specific treatments for disorders such as depression and schizophrenia," *Scientific American*, April; online at <<http://www.sciam.com/article.cfm?id=his-brain-her-brain>>. Cahill begins:

"On a gray day in mid-January, Lawrence Summers, the president of Harvard University, suggested that innate differences in the build of the male and female brain might be one factor underlying the relative scarcity of women in science. His remarks reignited a debate that has been smoldering for a century, ever since some scientists sizing up the brains of both sexes began using their main finding - that female brains tend to be smaller - to bolster the view that women are intellectually inferior to men. *To date, no one has uncovered any evidence that anatomical disparities might render women incapable of achieving academic distinction in math, physics or engineering.* [Our italics.] And the brains of men and women have been shown to be quite clearly similar in many ways. Nevertheless, over the past decade investigators have documented an astonishing array of structural, chemical and functional variations in the brains of males and females."

Larry Cahill <[http://www.faculty.uci.edu/profile.cfm?faculty\\_id=3276](http://www.faculty.uci.edu/profile.cfm?faculty_id=3276)> is an Associate Professor, Neurobiology and Behavior Group, School of Biological Sciences, at the Univ. of California – Irvine.

**#EB** \*Craver, C.F. 2007. *Explaining the Brain*. Oxford University Press, publisher's information at <<http://tinyurl.com/58h2kk>>:

"What distinguishes good explanations in neuroscience from bad? Carl F. Craver constructs and defends standards for evaluating neuroscientific explanations that are grounded in a systematic view of what neuroscientific explanations are: descriptions of multilevel mechanisms. In developing this approach, he draws on a wide range of examples in the history of neuroscience (e.g. Hodgkin and Huxleys model of the action potential and LTP as a putative explanation for different kinds of memory), as well as recent philosophical work on the nature of scientific explanation. Readers in neuroscience, psychology, the philosophy of mind, and the philosophy of science will find much to provoke and stimulate them in this book."

**#EB** \*Diamond M. C. 1996. "The Brain. Use It or Lose It." *Mind Shift Connection* 1: 1; online at <[http://www.newhorizons.org/neuro/diamond\\_use.htm](http://www.newhorizons.org/neuro/diamond_use.htm)>.

**#EB** Geary, D.C. 1998. *Male, Female: The Evolution of Human Sex Differences*. American Psychological Association, publisher's information at <<http://books.apa.org/books.cfm?id=431608A>>.

David Geary <<http://web.missouri.edu/~gearyd/>> "is a cognitive developmental psychologist with interests in mathematical learning and in evolution."

**#EB** Geary, D.C. 2002. "Principles of evolutionary educational psychology," *Learning and Individual Differences* 12: 317–345, online to subscribers at <<http://tinyurl.com/2zo3uq>>.

**#EB** Geary, D.C. 2005. *The origin of mind: Evolution of brain, cognition, and general intelligence*. American Psychological Association. Publisher's information at <<http://books.apa.org/books.cfm?id=4318015>>.

#EB Geary, D.C. 2006. “An Evolutionary Perspective on Sex Differences in Mathematics and the Sciences,” in Ceci & Williams (2006).

#EB Geary, D.C. 2007. *Educating the evolved mind: Conceptual Foundations for an Evolutionary Educational Psychology*, a volume in the series *Psychological Perspectives on Contemporary Educational Issues* edited by J.S. Carlson & J.R. Levin, Information Age, publisher’s information at <<http://www.infoagepub.com/products/content/978-1-59311-612-5.php>>. For a review see Taber (2007).

#EB Gur, R.C. & R.E. Gur. 2006. “Neural Substrates for Sex Differences in Cognition,” in Ceci & Williams (2006).

See also “Can Neuroscience Benefit Classroom Instruction?” [Hake (2006c)] and “Scientific and Pragmatic Challenges for Bridging Education and Neuroscience” [Varma *et al.* (2008)]

#EB Haier, R.J. 2006. “Brains, Bias, and Biology: Follow the Data,” in Ceci & Williams (2006). See also “Can Neuroscience Benefit Classroom Instruction?” [Hake (2006c)] and “Scientific and Pragmatic Challenges for Bridging Education and Neuroscience” [Varma *et al.* (2008)]

#EB \*Hake, R.R. 2006c. “Can Neuroscience Benefit Classroom Instruction?” online at <<http://listserv.nd.edu/cgi-bin/wa?A2=ind0610&L=pod&P=R6888&I=-3>>. Post of 12 Oct 2006 to POD and other discussion lists.

Abstract: I contrast the opinions of Judith Willis (2006) and John Bruer (1997) on the potential benefit of neuroscience to education. Willis' positive stance is moderated by her admission that neuroscience as applied to education has not been firmly validated. Bruer's negative stance is moderated by his belief that “eventually we will be able to bridge neuroscience at its various levels of analysis with education, but . . . all of these bridges will have a least one pier on the island of psychology.”

For a recent review by cognitive scientists of the relevance of neuroscience to education see Varma *et al.* (2008)

#EB \*Hake, R.R. 2007i. “Are Concepts Instantiated in Brain Synapses?” online at <<http://listserv.nd.edu/cgi-bin/wa?A2=ind0706&L=pod&P=R10342&I=-3>>. Post of 17 Jun 2007 to POD and other discussion lists.

#EB #IE \*Hake, R.R. 2007j. "Should We Measure Change? Yes!" online at <<http://www.physics.indiana.edu/~hake/MeasChangeS.pdf>> (2.5 MB), or as ref. 43 at <<http://www.physics.indiana.edu/~hake>>. To appear as a chapter in *Evaluation of Teaching and Student Learning in Higher Education*, a Monograph of the American Evaluation Association <<http://www.eval.org/>>. Therein I wrote (slightly edited):

"The Brain . . . Use It or Lose It . . . no matter what form enrichment takes, it is the challenge to the nerve cells that is important. Data indicate that passive observation is not enough; one must interact with the environment." [Marian Diamond (1996)]. *The superiority of IE methods in promoting conceptual understanding and higher-order learning is probably related to the "enhanced synapse addition and modification" induced by those methods.*

Cognitive scientists Bransford et al. (1999, 2000) stated: ". . . synapse addition and modification are lifelong processes, driven by experience. In essence, the quality of information to which one is exposed and the amount of information one acquires is reflected throughout life in the structure of the brain. This process is probably not the only way that information is stored in the brain, but it is a very important way that provides insight into how people learn."

Consistent with the above, the late biologist Robert Leamnson (1999, 2000) has stressed the relationship of biological brain change to student learning. In his first chapter "Thinking About Thinking and Thinking About Teaching," Leamnson (1999) defines teaching and learning thusly [our *italics*]

". . . teaching means any activity that has the conscious intention of, and potential for, *facilitation of learning in another. . . . learning is defined as stabilizing, through repeated use, certain appropriate and desirable synapses in the brain. . . .*"

And biologist James Zull (2003) in "What is The Art of Changing the Brain?" wrote [our *italics*]

"Although the human brain is immensely complicated, we have known for some time that it carries out four basic functions: getting information (sensory cortex,) making meaning of information (back integrative cortex), creating new ideas from these meanings (front integrative cortex,) and acting on those ideas (motor cortex.). . . [for Zull's schematic of the brain see <<http://www.case.edu/artsci/biol/people/zull.html>>]. . . . From this I propose that there are four pillars of human learning: gathering, analyzing, creating, and acting. This isn't new, but its match the structure of the brain seems not to have been noticed in the past. *So I suggest that if we ask our students to do these four things, they will have a chance to use their whole brain.*"

For pro and con articles on the relevance of neuroscience to present-day classroom instruction see e.g., PRO: Lawson (2006) and Willis (2006); CON: Marchese (2002) and Bruer (1997, 2006). See also the commentary on Willis (2006) and Bruer (2006) by Hake (2006c) and Redish (2006).

#EB \*Hestenes, D. 1987a. "How the Brain Works: The next great scientific revolution," in C.R. Smith and G.J. Erickson, eds., *Maximum Entropy and Bayesian Spectral Analysis and Estimation Problems*. Reidel, Dordrecht/Boston, pp. 173-205. See Hestenes (1987b) for a discussion of "How the Brain Works."

#EB \*Hestenes, D. 1987b. "Toward a modeling theory of physics instruction," *Am. J. Physics*. 55(5): 440-454, online at <<http://modeling.la.asu.edu/R&E/Research.html>>.

#EB Hines, M. 2004. *Brain Gender*. Oxford University Press, publisher's information at <<http://tinyurl.com/67soat>>:

"This book brings a social developmental, as well as a biological and clinical psychological, perspective to bear on the factors that shape our development as male or female, and that cause individuals within each sex to differ from one another in sex-related behaviors. Topics covered include sexual orientation, childhood play, spatial, *mathematical and verbal abilities*, nurturance, aggression, dominance, handedness, *brain structure*, and gender identity. This original and accessible book is of interest to psychologists, neuroscientists, pediatricians, and educators, as well as the general public. It is also used in graduate and undergraduate courses on the psychology of gender and on hormones and behavior. . . . . Melissa Hines is a Professor of Psychology and Director, Behavioural Neuroendocrinology Research Unit, City University, London." [Our *italics*.]

#EB \*Kandel. E.R. 2006. *In Search of Memory: The Emergence of a New Science of Mind*. W.W. Norton. Norton information at <<http://www2.wwnorton.com/catalog/fall06/032937.htm>>. See also Squire & Kandel (2000).

#EB #SDMA Kimura, D. 2000. *Sex and Cognition*. MIT Press, publisher's information at <<http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=4364>>. Amazon.com information at <<http://tinyurl.com/6pd2nb>>. Note the "Look Inside" feature. The following quote is at the MIT press site:

"Kimura provides an authoritative overview of the field of sex differences in cognition, moving from hormones to cognition, genes to behavior, in a calm and clear way. This book will be a valuable resource for students and teachers of cognitive science."-- Simon Baron-Cohen, Departments of Experimental Psychology and Psychiatry, University of Cambridge, UK.

Doreen Kimura <<http://www.sfu.ca/~dkimura/dkhome.htm>> writes: "I have a post-retirement visiting professorship at Simon Fraser University in Burnaby, British Columbia. Prior to that I spent over 30 years at the University of Western Ontario in London, Canada."

#EB #SDMA Kimura, D. 2002. "Sex Differences in the Brain," *Scientific American*, 13 May 13, abstract online at <<http://tinyurl.com/548ube>>. Kimura wrote:

"Men and women differ not only in their physical attributes and reproductive function but also in many other characteristics, including the way they solve intellectual problems. For the past few decades, it has been ideologically fashionable to insist that these behavioral differences are minimal and are the consequence of variations in experience during development before and after adolescence. *Evidence accumulated more recently, however, suggests that the effects of sex hormones on brain organization occur so early in life that from the start the environment is acting on differently wired brains in boys and girls.* [Our *italics*.] Such effects make evaluating the role of experience, independent of physiological predisposition, a difficult if not dubious task. The biological bases of sex differences in brain and behavior have become much better known through increasing numbers of behavioral, neurological and endocrinological studies."

#EB \*Lawson, A.E. 2003. *The Neurological Basis of Learning, Development and Discovery: Implications for Science and Mathematics Instruction*. Springer. Amazon.com information at <<http://tinyurl.com/2ue87x>> :

“*The Neurological Basis of Learning, Development and Discovery* is unique in that it: (a) links neural physiology and neural network theory with cognition and instructional practice; (b) grounds the current emphasis on inquiry and constructivism in epistemological, philosophical and developmental theory; (c) *links neural network theory, learning theory, conceptual change theory, and scientific discovery to classroom practice* (our *italics*); (d) provides examples of scientifically-based research in education as a guide for science and math educators and graduate students; (e) has examples of lessons that can teach discipline-specific concepts as well as provoke the development of general reasoning/argumentative skills; (f) can be used in graduate-level courses in science education and in-service courses for science teachers.”

#EB \*Lawson, A.E. 2006. “Points of View: On the Implications of Neuroscience Research for Science Teaching and Learning: Are There Any?” *CBE-Life Sciences Education* 5: 111-117, online at <<http://www.lifescied.org/cgi/content/full/5/2/111>>.

Leamnson, R. 1999. “*Thinking About Teaching and Learning: Developing Habits of Learning with First Year College and University Students*.” Stylus. Stylus information at <<http://styluspub.com/Books/BookDetail.aspx?productID=20839>>.

#EB Leamnson, R. 2000. “Learning as Biological Brain Change,” *Change*, November/December; online at <<http://www.umassd.edu/cas/biology/lbk1.cfm>>.

#EB \*Library of Congress, 2006c. “The Brain,” Tracer Bullet 90-10, Science Reference Services; online at <<http://www.loc.gov/rr/scitech/tracer-bullets/braintb.html.html>>.

#EB \*Marchese, T.J. 1997. “The New Conversations About Learning: Insights From Neuroscience and Anthropology, Cognitive Science and Workplace Studies,” *Assessing Impact: Evidence and Action*, American Association for Higher Education (now defunct), Washington DC, pp. 79-95, online at <[http://www.newhorizons.org/lifelong/higher\\_ed/marchese.htm](http://www.newhorizons.org/lifelong/higher_ed/marchese.htm)>.

#EB #SDMA Pinker, S. 2003. *Blank Slate: The Modern Denial of Human Nature*. Penguin Group.

Barnes & Noble information at

<<http://search.barnesandnoble.com/Blank-Slate/Steven-Pinker/e/9780142003343/?itm=2>>.

Note the “See Inside” feature.

From *Publishers Weekly*:

.....Drawing on decades of research in the “sciences of human nature,” Pinker, a chaired professor of psychology at MIT, attacks the notion that an infant’s mind is a blank slate, arguing instead that human beings have an inherited universal structure shaped by the demands made upon the species for survival, albeit with plenty of room for cultural and individual variation. .... He goes on to tour what science currently claims to know about human nature, including its cognitive, intuitive and emotional faculties, and *shows what light this research can shed on such thorny topics as gender inequality, child-rearing and modern art.* [Our *italics*.]

Pinker’s advertisement at <<http://pinker.wjh.harvard.edu/books/tbs/index.html>> states:

“In *The Blank Slate*, Steven Pinker, bestselling author of *The Language Instinct* and *How the Mind Works*, explores the idea of human nature and its moral, emotional, and political colorings. He shows how many intellectuals have denied the existence of human nature by embracing three linked dogmas: The Blank Slate (the mind has no innate traits), The Noble Savage (people are born good and corrupted by society), and The Ghost in the Machine (each of us has a soul that makes choices free from biology). Each dogma carries a moral burden, so their defenders have engaged in the desperate tactics to discredit the scientists who are now challenging them.

Pinker tries to inject calm and rationality into these debates by showing that equality, progress, responsibility, and purpose have nothing to fear from discoveries about rich human nature. He disarms even the most menacing threats with clear thinking, common sense, and pertinent facts from science and history. Despite its popularity among intellectuals during much of the twentieth century, he argues, the doctrine of the Blank Slate may have done more harm than good. It denies our common humanity and our individual preferences, replaces hardheaded analyses of social problems with feel-good slogans, and distorts our understanding of government, violence, parenting, and the arts.”

An interview with Pinker regarding this book is online as “A Biological Understanding Of Human Nature: A Talk With Steven Pinker” at

<[http://www.edge.org/3rd\\_culture/pinker\\_blank/pinker\\_blank\\_print.html](http://www.edge.org/3rd_culture/pinker_blank/pinker_blank_print.html)>.

According to Hemel’s (2005b) interview with Lawrence Summers, Summers’ speculation on innate gender differences in math/science abilities came from scholars cited in Pinker’s (2003) *The Blank Slate: The Modern Denial of Human Nature*. According to reference 20 in the AWM’s (2005) petition background, among the scholars cited by Pinker are Hedges and Nowell (1995) and Lubinski and Benbow (1992).

#EB #SSIGD #SDMA Pinker, S. & E. Spelke. 2005. "The Science Of Gender And Science - Pinker vs. Spelke - A Debate on the research on mind, brain, and behavior that may be relevant to gender disparities in the sciences, including the studies of bias, discrimination and innate and acquired difference between the sexes," online at

<[http://www.edge.org/3rd\\_culture/debate05/debate05\\_index.html](http://www.edge.org/3rd_culture/debate05/debate05_index.html)>. See also Pinker (2003) and a video of the debate at <[http://www.edge.org/3rd\\_culture/bios/pinker.html](http://www.edge.org/3rd_culture/bios/pinker.html)>. An excerpt from the Introduction to the debate is as follows:

"On April 22, 2005, Harvard University's Mind/Brain/Behavior Initiative (MBB) held a defining debate on the public discussion that began on January 16th with the public comments by Lawrence Summers, president of Harvard, on sex differences between men and women and how they may relate to the careers of women in science. The debate at MBB, 'The Gender of Gender and Science' was 'on the research on mind, brain, and behavior that may be relevant to gender disparities in the sciences, including the studies of bias, discrimination and innate and acquired difference between the sexes.' It's interesting to note that since the controversy surrounding Summers' remarks began, there has been an astonishing absence of discussion of the relevant science...you won't find it in the hundreds and hundreds of articles in major newspapers; nor will find it in the Harvard faculty meetings where the president of the leading University in America was indicted for presenting controversial ideas. . . . . But unlike just about anything else said about Summers' remarks, the debate, 'The Science of Gender and Science,' between Harvard psychology professors Steven Pinker and Elizabeth Spelke, focused on the relevant scientific literature. It was both interesting on facts but differing in interpretation (sic)."

An interesting excerpt of Pinker's side of the debate is as follows:

"For those of you who just arrived from Mars, there has been a certain amount of discussion here at Harvard on a particular datum, namely the under-representation of women among tenure-track faculty in elite universities in physical science, math, and engineering. . . . . Here are some recent numbers: Percentages of female faculty in tenure track positions in elite universities: Math: 8.3%, Chemistry: 12.1%, Chemical Engineering: 10.5%, Physics: 6.6%, Mechanical Engineering: 6.7%, Electrical Engineering: 6.5%, Civil Engineering: 9.8%, Computer Science: 10.6%, Astronomy: 12.6%. . . . [Our insert – no source for these numbers is given.]

As with many issues in psychology, there are three broad ways to explain this phenomenon. One can imagine an extreme 'nature' position: that males but not females have the talents and temperaments necessary for science. Needless to say, only a madman could take that view. The extreme nature position has no serious proponents.

There is an extreme 'nurture' position: that males and females are biologically indistinguishable, and all relevant sex differences are products of socialization and bias.

Then there are various intermediate positions: that the difference is explainable by some combination of biological differences in average temperaments and talents interacting with socialization and bias.

Liz [Spelke] has embraced the extreme nurture position. . . . .Liz has said that there is 'not a shred of evidence' for the biological factor, that 'the evidence against there being an advantage for males in intrinsic aptitude is so overwhelming that it is hard for me to see how one can make a case at this point on the other side,' and that 'it seems to me as conclusive as any finding I know of in science.'

These are extreme statements — especially in light of the fact that an enormous amount of research, summarized in these and many other literature reviews, in fact points to a very different conclusion. I'll quote from one of them, a book called *Sex Differences in Cognitive Ability*. . . . [Diane Halpern (2000)]. . . . She is a respected psychologist, recently elected as president of the American Psychological Association, and someone with no theoretical axe to grind. She does not subscribe to any particular theory, and has been a critic, for example, of evolutionary psychology. And here is what she wrote in the preface to her book:

‘At the time I started writing this book it seemed clear to me that any between sex differences in thinking abilities were due to socialization practices, artifacts, and mistakes in the research. After reviewing a pile of journal articles that stood several feet high, and numerous books and book chapters that dwarfed the stack of journal articles, I changed my mind. The literature on sex differences in cognitive abilities is filled with inconsistent findings, contradictory theories, and emotional claims that are unsupported by the research. Yet despite all the noise in the data, clear and consistent messages could be heard. There are real and in some cases sizable sex differences with respect to some cognitive abilities. Socialization practices are undoubtedly important, but there is also good evidence that biological sex differences play a role in establishing and maintaining cognitive sex differences, a conclusion I wasn't prepared to make when I began reviewing the relevant literature.’ ”

#EB \*Redish, E.F. 2006. “Re: Can Neuroscience Benefit Classroom Instruction?” PhysLrnR post 15 Oct 2006 22:12:17-0400; online at <<http://tinyurl.com/tqzhe>>. In the last sentence, the URL for Redish’s American Association of Physics Teachers (AAPT) talk “How having a theory of learning changes what I do in class on Monday,” should have been given as <<http://www.physics.umd.edu/perg/talks/redish/Monday.pdf>> (2.1 MB).

#EB \*Roediger, H.L., Y. Dudai, & S.M. Fitzpatrick, eds. 2007. *Science of Memory: Concepts*. Oxford University Press, publisher’s information at <<http://tinyurl.com/6ao2zc>> :

“Scientists currently study memory from many different perspectives: neurobiological, ethological, animal conditioning, cognitive, behavioral neuroscience, social, and cultural. The aim of this book is to help initiate a new science of memory by bringing these perspectives together to create a unified understanding of the topic. The book began with a conference where leading practitioners from all these major approaches met to analyze and discuss 16 concepts that are crucial to our understanding of memory. Each of these 16 concepts is addressed in a section of the book, and in the 66 succinct chapters that fill these sections, a leading researcher addresses the section's concept by clearly stating his or her position on it, elucidating how it is used, and discussing how it should be used in future research. For some concepts, there is general agreement among practitioners from different fields and levels of analysis, but for others there is general disagreement and much controversy. A final chapter in each section, also written by a leading researcher, integrates the various viewpoints offered on the section's concept, then draws conclusions about the concept. This groundbreaking volume will be an indispensable reference for all the students and researchers who will build upon the foundation it provides for the new science of memory.”

#EB \*Shermer, M. 2008. “The Brain Is Not Modular: What fMRI Really Tells Us: Metaphors, modules and brain-scan pseudoscience,” *Scientific American*, May; online at <<http://www.sciam.com/article.cfm?id=a-new-phrenology&sc=rss>>. [fMRI = functional magnetic resonance imaging.]

**#EB** \*Squire, L.R. & E.R. Kandel. 2000. *Memory: From Mind to Molecules*. W.H. Freeman. Amazon.com information at <<http://tinyurl.com/5yoxes>>. A Google “book preview” is online at <<http://tinyurl.com/3q3qug>>. See also Kandel (2006).

**#EB** \*Varma, S, B.D. McCandliss, & D.L. Schwartz. 2008. “Scientific and Pragmatic Challenges for Bridging Education and Neuroscience,” *Educational Researcher* 37(3): 140–152; online to subscribers at <[http://www.aera.net/publications/Default.aspx?menu\\_id=38&id=5238](http://www.aera.net/publications/Default.aspx?menu_id=38&id=5238)>, The abstract reads:

“Educational neuroscience is an emerging effort to integrate neuroscience methods, particularly functional neuroimaging, with behavioral methods to address issues of learning and instruction. This article consolidates common concerns about connecting education and neuroscience. One set of concerns is *scientific*: in-principle differences in methods, data, theory, and philosophy. The other set of concerns is *pragmatic*: considerations of costs, timing, locus of control, and likely payoffs. The authors first articulate the concerns and then revisit them, reinterpreting them as potential opportunities. They also provide instances of neuroscience findings and methods that are relevant to education. The goal is to offer education researchers a window into contemporary neuroscience to prepare them to think more specifically about the prospects of educational neuroscience.”

**#EB** Willis, J. 2006. “Research Watch II: Add the Science of Learning to the Art of Teaching to Enrich Classroom Instruction,” *National Teaching and Learning Forum* 15(5), online to subscribers at <<http://www.ntlf.com/FTPSite/issues/v15n5/research2.htm>>. If your institution doesn't have a subscription, then IMHO it should!

## E. Gender & Spatial Visualization #SV

#SV Baartmans, B.G. and S.A. Sorby. 1996. "Making Connections: Spatial Skills and Engineering Drawings," *The Mathematics Teacher* **89**(4): 348-357.

#SV Friedman, L. 1995. "The space factor in mathematics: gender differences," *Review of Educational Research* **65**(1): 22-50. Abstract online at

< <http://rer.sagepub.com/cgi/content/abstract/65/1/22> >. Friedman wrote :

"The relationship of spatial and mathematical skills has been the subject of both speculation and empirical investigation. A meta-analysis of correlations of spatial and mathematical skills has found that these are not high, and that correlations of verbal and mathematical skills are higher. Many researchers have suggested that the space-math relationship may be gender-specific. The further meta-analytic results reported here show that in selected samples, math-space correlations are higher in females than in males, with the difference becoming more pronounced with greater selectivity. Because these samples are of gifted or college-bound youth, explanations which emphasize career-directed attitudes in the interplay of spatial and mathematical skills are suggested."

#SV \*Geary, D.C., & M.C. DeSoto. 2001. "Sex differences in spatial abilities among adults from the United States and China: Implications for evolutionary theory." *Evolution and Cognition* **7**: 172-177; online at < <http://web.missouri.edu/~gearyd/Geary&DeSoto.pdf> >(1.2 MB). The abstract reads:

"Sex differences on tests of spatial abilities were examined for two samples of adults from the United States (U.S.) and China. In Study 1, an inconsistent pattern of sex differences emerged for tests that largely required subjects to mentally rotate representations of geometric figures in two dimensions. A male advantage on the Mental Rotation Test (MRT), a test that requires subjects to mentally rotate geometric figures in three dimensions, was found for both the U.S. (n = 66) and Chinese (n = 40) samples. Study 2 included larger samples and replicated the sex difference on the MRT. It was also shown that in both the U.S. (n= 237) and China (n= 218), males were over-represented at the high end of MRT scores, and females were over-represented at the low end of MRT scores. The results support the position that the male superiority in 3-dimensional spatial cognition is not dependent upon culture."

#SV #IE Hake, R.R. 2002b. "Relationship of Individual Student Normalized Learning Gains in Mechanics with Gender, High-School Physics, and Pretest Scores on Mathematics and Spatial Visualization," submitted to the Physics Education Research Conference; Boise, Idaho; August 2002; online at

< <http://www.physics.indiana.edu/~hake/PERC2002h-Hake.pdf> > (220 kB).

I found a gender-difference effect size for average normalized gains  $\langle g \rangle$  of 0.58 for an introductory mechanics course IU95S. Meltzer (2002) calculated gender-difference effect sizes of 0.44 and 0.59 for two classes [N = 59, 78] at Iowa State University, but observed no significant gender difference in two other classes [N = 45, 37] at Southeastern Louisiana University. . . . the  $\langle g \rangle$  dependence on the gender 'hidden variable' is small relative to the very strong dependence of  $\langle g \rangle$  on the degree of interactive engagement (effect size 2.43). . . . "Therefore, in my opinion, **efforts to move traditional instruction more towards the interactive engagement for ALL students should receive a higher priority than concern for the apparently relatively small gender differences in test results discussed** by McCullough (2001) and Crouch & McCullough (2001).

- #SV Howe, A.C. and W. Doody. 1989. "Spatial visualization and sex-related differences in science achievement." *Science Educ.* **73**: 703-709.
- #SV Linn, M.C. & A.C. Petersen. 1986. "A meta-analysis of gender differences in spatial ability: Implications for mathematics and science achievement," in Hyde & Linn (1986).
- #SV Lord, T.R. 1987. "A Look at Spatial Abilities in Undergraduate Women Science Majors," *Journal of Research in Science Teaching* **24**(8): 757-767; abstract online at <<http://tinyurl.com/6qs5n8>>.
- #SV Newcombe, N.S. 2006. "Taking Science Seriously: Straight Thinking About Spatial Sex Differences," in Ceci & Williams (2006).
- #SV Pallrand, G.J. & F. Seeber, 1984. "Spatial Ability and Achievement in Introductory Physics." *Journal of Research in College Teaching* **21**(5): 507-516; abstract online at <<http://tinyurl.com/4qwlb2>>:  
"This research was undertaken to clarify the nature of the relationship between visual-spatial abilities and achievement in science courses. A related purpose was to determine what influence visual-spatial abilities have on the high attribution rate characteristic of many introductory college-level science courses. Three sections of introductory college level physics ( $S = 136$ ) and one nonscience liberal arts section ( $S = 52$ ) received pre- and postmeasures of visual-spatial ability in the areas of perception, orientation, and visualization. Increases in visual-spatial abilities were greatest with an experimental section that received a spatial intervention. These gains were related to test items that utilized graphical form and to laboratory work. Substantial gains in visual-spatial ability were also registered by a placebo and by control sections. These increases suggest that taking introductory physics improves visual-spatial abilities. Although students who withdrew from the course demonstrated mathematics skills comparable to those of students who completed the course, their scores on perception tests were appreciably lower. Visual-spatial scores of the liberal arts group were lower than those of the physics sections, suggesting that visual-spatial ability influences course selection."
- #SV Sorby, S.A., F. Wysocki, B.J. Baartmans. 2002. *Introduction to 3D Spatial Visualization: An Active Approach*. ENGAGE Delmar Learning. Amazon.com information at <<http://tinyurl.com/3cv9ea>>. Note the "Search Inside" feature.  
On average, males usually score about two standard deviations above females on spatial visualization tests. This difference is often attributed to cultural factors. Supporting this assumption, Sorby *et al.* showed that women engineers at Michigan Technological University could perform as well as men on spatial visualization tests if brought up to speed by a one-quarter (6 hr/week) visualization course based on this text.
- #SV Voyer, D., S. Voyer, & M.P. Bryden. 1995. "Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables," *Psychological Bulletin* **117**: 250-270; abstract online at <<http://tinyurl.com/5l5uoj>>.

## **F. Harvard President Summers' Speculation on Innate Gender Differences in Science and Math Ability #SSIGD**

#SSIGD Bombardieri, M. 2005. "Summers displays new understanding of women's careers," *Boston Globe*, 8 April; online at <<http://tinyurl.com/728fv>>. Bombardieri wrote:

"Addressing a symposium last night on women in science, Harvard University's president, Lawrence H. Summers, could hardly have sounded more transformed from the man who discussed the same issue in January. Summers's comments last night about the effects of subtle, unconscious bias against women and the impact of encouragement or discouragement on young minds were virtually diametrically opposite from those he made at a National Bureau of Economic Research conference three months ago."

#SSIGD Gordon, C. 2005. "Response . . . [To Summers]. . . from the AWM Community," online at <<http://www.awm-math.org/response.html>> also contains "Responses of other mathematical sciences organizations." Carolyn Gordon was, at the time, president of the Association for Women in Mathematics.

#SSIGD Hemel, D.J. 2005a. "Summers' Comments on Women and Science Draw Ire: Remarks at private conference stir criticism, media frenzy," *Harvard Crimson*, 14 January, online at <<http://www.thecrimson.com/article.aspx?ref=505349>>. Hemel wrote:

"Harvard President Lawrence H. Summers has triggered criticism by telling an economics conference Friday that the under-representation of female scientists at elite universities may stem in part from "innate" differences between men and women, although two Harvard professors who heard the speech said the remarks have been taken out of context in an ensuing national media frenzy."

Our thanks to Moira McDermott for this reference, given on her site

<<http://www.gustavus.edu/~mmcdermo/women-science-links.html>> as "Summers' comments."

#SSGD #SDMA Hemel, D.J. 2005b. "Sociologist Cited By Summers Calls His Talk 'Uninformed'" *Harvard Crimson*, 19 January, online at <<http://www.thecrimson.com/article.aspx?ref=505363>>. Hemel wrote:

Two sociologists whose research University President Lawrence H. Summers cited at an economics conference Friday said yesterday their findings do not support Summers' suggestion that "innate differences" may account for the under-representation of women in the sciences.

University of California-Davis sociologist Kimberlee A. Shauman said that Summers' remarks were "uninformed." The other researcher, University of Michigan sociologist Yu Xie, said he accepted Summers' comments as "scholarly propositions," although he said his own analysis "goes against Larry's suggestion that math ability is something innate."

Xie and Shauman presented their findings at the National Bureau of Economic Research Friday afternoon, shortly after Summers' remarks.

In an interview with The Crimson last night, Summers stressed that he only cited Xie and Shauman's research. . . . [our insert - see Xie & Shauman (2005)]. . . . as evidence that females are underrepresented among the top 5 percent of test-takers on standardized assessments. *Summers said the evidence for his speculative hypothesis that biological differences may partially account for this gender gap comes instead from scholars cited in Johnstone Family Professor of Psychology Steven Pinker's bestselling 2003 book The Blank Slate: The Modern Denial of Human Nature. . . . [Our italics.]* [Our insert – according to reference 20 of the background information for the AWM's (2005) petition "Concern regarding the inclusion of Dr. Camilla Benbow on the National Mathematics Advisory Panel," among the scholars cited by Pinker are Hedges and Nowell (1995) and Lubinski and Benbow (1992).]

#SSIGD Jaschik, S. 2006. "Summers Postmortem, Beyond Cambridge," *Inside Higher Ed*, online at <<http://insidehighered.com/news/2006/02/22/summers>>.

#SSIGD #SDMA Kimura, D. 2004. "Hysteria trumps academic freedom," *Vancouver Sun*, p. A13, 1 February; online at <<http://www.sfu.ca/~dkimura/articles/hysteria.htm>>. Kimura wrote:

The recent suggestion by Larry Summers, Harvard University president, that one of the factors contributing to the lower representation of women in the sciences might be innate differences between the sexes has unleashed the predictable fury from feminists and their fellow ideologues. The responses to Summers indicate once again how little respect many in academia really have for the principles of academic freedom and rational discussion. Even had he been mistaken, the reaction should have been more moderate, but as it happens he was not.

Men and women do differ in their intellectual talents, and if by "innate" we mean influenced or determined before birth, then some of these differences are indeed innate. Differentiation between the sexes depends heavily on the difference between them in levels of sex hormones early in prenatal life. These hormone levels determine not only the physical differences, but also strongly influence many behaviours into adulthood. Those behaviours include the intellectual or cognitive pattern, hormonal influences being especially well documented for certain kinds of spatial ability, like being able to mentally rotate or manipulate visual objects.

Men are, on average, better on such spatial tasks and on mathematical reasoning tasks than are women. Women, in contrast are better, on average, on tasks requiring verbal memory (recalling word material), and also in recalling the position of objects presented in an array. There are many other less striking differences.

Mathematical reasoning ability is especially important for physical sciences like physics and engineering, and since many more men than women score at the high end of math aptitude tests, it is reasonable to expect that more men will go into those professions. Note that boys and girls may not differ in their grades on math tests in school, but the same boys still excel on math aptitude tests, where the items are less rehearsed. . . . .

Lest some people think that women still suffer discrimination in hiring in academia, the research, in Canada at least, shows just the opposite. Several studies have shown that women are favoured over men in university faculty hiring, including my own survey of hiring at two major British Columbia universities. Women's groups have been sadly effective at crying victim, to the point where men have become disadvantaged.

Dr. Summers has now disappointed all serious academics by his subsequent apology and retraction, bowing to pressures originating, not from thoughtful critiques of his remarks, but from hysterical reactions of special interest groups. His response is mirrored in too many university and research grant administrations, where the tired refrain is that women still suffer “serious obstacles”, at best only vaguely defined, to success in science.

#SSIGD McDonnell, F. 2005. “Why so few choose physics: An alternative explanation for the leaky pipeline,” *Am. J. Phys.* **73**(7): 583-586, online at <<http://www.warren-wilson.edu/~physics/FacultyInterest/AJP000583.pdf>> (152 kB).

McDonnell wrote:

“Recent remarks by Harvard University President Lawrence Summers have sparked controversy. However, the notion that the ‘very substantial under-representation’ of women in physics is explained by the ‘intrinsic’ deficiencies of ‘available aptitude’ is hardly novel. Indeed, as recently as 1990, in a piece titled ‘Women—why so few?’, Professor Michael Levin (1990) argued that innate cognitive gender differences between the sexes make gender equity in physics both an unrealistic and perhaps undesirable reality. According to the cognitive difference model, the disproportionate loss of women—and by extension, any group not currently represented in the field—is explained in terms of innate differences in ability, most notably differences in mathematical aptitude: those with aptitude in mathematics (mostly men) continue in physics, while those lacking mathematical aptitude (mostly women) switch to other fields. Yet, the question of innate differences is far from resolved. Studies reported by Mary Beth Ruskai (1991) in her response to Michael Levin and more recent studies reported by David C. Geary (1998) and Yu and Kimberlee A. Shauman (2005) make it clear that any differences that may exist between the sexes are small, appear to be responsive to instruction, are restricted to specific areas of mathematics, and pale in light of differences across cultures.”

McDonnell concludes:

“As Gerhard Sonnert (1999b) has noted, ‘If the structural and cultural causes for the leaks are ignored, attempts at increasing the representation of women at the various pipeline segments may fall short.’ By taking seriously the instructional and socio-cultural aspects of physics teaching, and by providing opportunities for what David Layzer. . . . [our insert - Harvard Emeritus Professor of Astrophysics, in a piece titled “Why women (and men!) give up on science” in *On Teaching and Learning*, a journal of the Derek Bok Center, Harvard University, May 1992, pp. 67–77]. . . . describes as ‘invention and ingenuity,’ especially during the early junctures of the academic pipeline, students might form a more inclusive view of physics and physicists, and the physical sciences might appeal to a wider diversity of students.”

**SSIGD** Otwell, S. 2005. "CSWP Responds to Harvard University President's Comments," CSWP Gazette, Spring, online at <<http://www.apa.org/programs/women/reports/gazette/upload/spring05.pdf>> (748 kB).

**#EB #SSIGD #SDMA** Pinker, S. & E. Spelke. 2005. "The Science Of Gender And Science - Pinker vs. Spelke - A Debate on the research on mind, brain, and behavior that may be relevant to gender disparities in the sciences, including the studies of bias, discrimination and innate and acquired difference between the sexes," online at <[http://www.edge.org/3rd\\_culture/debate05/debate05\\_index.html](http://www.edge.org/3rd_culture/debate05/debate05_index.html)>. See also Pinker (2003) and a video of the debate at <[http://www.edge.org/3rd\\_culture/bios/pinker.html](http://www.edge.org/3rd_culture/bios/pinker.html)>. An excerpt from the Introduction to the debate is as follows:

"On April 22, 2005, Harvard University's Mind/Brain/Behavior Initiative (MBB) held a defining debate on the public discussion that began on January 16th with the public comments by Lawrence Summers, president of Harvard, on sex differences between men and women and how they may relate to the careers of women in science. The debate at MBB, 'The Gender of Gender and Science' was 'on the research on mind, brain, and behavior that may be relevant to gender disparities in the sciences, including the studies of bias, discrimination and innate and acquired difference between the sexes.' It's interesting to note that since the controversy surrounding Summers' remarks began, there has been an astonishing absence of discussion of the relevant science...you won't find it in the hundreds and hundreds of articles in major newspapers; nor will find it in the Harvard faculty meetings where the president of the leading University in America was indicted for presenting controversial ideas. . . . . But unlike just about anything else said about Summers' remarks, the debate, 'The Science of Gender and Science,' between Harvard psychology professors Steven Pinker and Elizabeth Spelke, focused on the relevant scientific literature. It was both interesting on facts but differing in interpretation (sic)."

An interesting excerpt of Pinker's side of the debate is as follows:

"For those of you who just arrived from Mars, there has been a certain amount of discussion here at Harvard on a particular datum, namely the under-representation of women among tenure-track faculty in elite universities in physical science, math, and engineering. . . . . Here are some recent numbers: Percentages of female faculty in tenure track positions in elite universities: Math: 8.3%, Chemistry: 12.1%, Chemical Engineering: 10.5%, Physics: 6.6%, Mechanical Engineering: 6.7%, Electrical Engineering: 6.5%, Civil Engineering: 9.8%, Computer Science: 10.6%, Astronomy: 12.6%. . . . [Our insert – no source for these numbers is given.]

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These are extreme statements — especially in light of the fact that an enormous amount of research, summarized in these and many other literature reviews, in fact points to a very different conclusion. I'll quote from one of them, a book called *Sex Differences in Cognitive Ability*. . . . [Diane Halpern (2000)].. .

.... She is a respected psychologist, recently elected as president of the American Psychological Association, and someone with no theoretical axe to grind. She does not subscribe to any particular theory, and has been a critic, for example, of evolutionary psychology. And here is what she wrote in the preface to her book:

‘At the time I started writing this book it seemed clear to me that any between sex differences in thinking abilities were due to socialization practices, artifacts, and mistakes in the research. After reviewing a pile of journal articles that stood several feet high, and numerous books and book chapters that dwarfed the stack of journal articles, I changed my mind. The literature on sex differences in cognitive abilities is filled with inconsistent findings, contradictory theories, and emotional claims that are unsupported by the research. Yet despite all the noise in the data, clear and consistent messages could be heard. There are real and in some cases sizable sex differences with respect to some cognitive abilities. Socialization practices are undoubtedly important, but there is also good evidence that biological sex differences play a role in establishing and maintaining cognitive sex differences, a conclusion I wasn't prepared to make when I began reviewing the relevant literature.’ ”

#SSIGD Sommers, C.H. 2007. “Academic Inquisitors,” *Wall Street Journal*, 16 October online at <[http://www.aei.org/publications/pubID.26967,filter.all/pub\\_detail.asp](http://www.aei.org/publications/pubID.26967,filter.all/pub_detail.asp)>. Sommers wrote:

“As if losing the presidency of Harvard for hinting that there might be a biological explanation for the preponderance of men in academic science wasn't enough, Lawrence Summers now appears to be *persona non grata* elsewhere too.

A few weeks ago the University of California, Davis rescinded an invitation for him to speak. More than 150 faculty members signed a petition protesting his appearance, saying Mr. Summers ‘has come to symbolize gender and racial prejudice in academia.’ Davis ecology Professor Maureen Stanton was ‘appalled and stunned that someone like Summers would be invited to speak.’

Ms. Stanton and her allies want pariah status for anyone who dares to suggest a biological basis for difference. Yet the scientific literature on why men and women enter different fields is legitimate, robust, complex and fascinating. What is appalling is that leading academic institutions would try to shut down the discussion and get away with it. Almost.

Last week, the American Enterprise Institute brought together top researchers on sex differences, ranging from the strongly feminist Brandeis women’s studies scholar Rosalind Barnett to AEI scholar and co-author of *The Bell Curve*, Charles Murray. . . . [our insert – see AEI (2007)]. . . . The discussions were heated, but civil. No one got mad, fled the room weeping, or nearly fainted.”

Christina Hoff Sommers is an AEI (2008) resident scholar  
<<http://www.aei.org/scholars/scholarID.56,filter.all/scholar.asp>>.

#SSIGD #SDMA Summers, L.H. 2005. “Remarks at NBER Conference on Diversifying the Science & Engineering Workforce” [NBER = National Bureau of Economic Research]

<<http://www.nber.org/>>], transcript online at

<<http://www.president.harvard.edu/speeches/2005/nber.html>>. Summers said [our *italics*]:

“There are three broad hypotheses about the sources of the very substantial disparities that this conference's papers document and have been documented before with respect to the presence of women in high-end scientific professions. . . . .the first is what I call the *high-powered job hypothesis*. The second is what I would call *different availability of aptitude at the high end*, and the third is what I would call *different socialization and patterns of discrimination in a search*. And in my own view, their importance probably ranks in exactly the order that I just described.”

The second hypothesis “*different availability of aptitude at the high end*” drew the attention of academics, created a firestorm in the media, resulted in Summers’ resignation, and is encapsulated in the following provocative excerpt from the transcript:

“. . . why is the representation [of women] even lower and more problematic in science and engineering than it is in other fields. And here, you can get a fair distance, it seems to me, looking at a relatively simple hypothesis. It does appear that on many, many different human attributes - height, weight, propensity for criminality, overall IQ, mathematical ability, scientific ability - there is relatively clear evidence that whatever the difference in means - which can be debated - *there is a difference in the standard deviation, and variability of a male and a female population. And that is true with respect to attributes that are and are not plausibly, culturally determined.* [Our *italics*.] If one supposes, as I think is reasonable, that if one is talking about physicists at a top twenty-five research university, one is not talking about people who are two standard deviations above the mean. And perhaps it's not even talking about somebody who is three standard deviations above the mean. But it's talking about people who are three and a half, four standard deviations above the mean in the one in 5,000, one in 10,000 class. Even small differences in the standard deviation will translate into very large differences in the available pool . . .[our insert - the transcript has “substantially out” at this point and is probably garbled – Summers probably meant something like “at the high-end tail of the distribution”].

Our thanks to Moira McDermott for this reference, given on her site

<<http://www.gustavus.edu/~mmcdermo/women-science-links.html>> as “Transcript of Summers’ remarks.”

#SSIGD Tretkoff, E. 2005b. “CSWP Responds to Harvard University President’s Comments,” APS News, March; online at <<http://www.aps.org/publications/apsnews/200503/cswp.cfm>>.

## G. Hollywood Actress Danica McKellar's book Math Doesn't Suck #DM

#DM Chayes, L., D. McKellar, and B. Winn. 1998. "Percolation and Gibbs state multiplicity for ferromagnetic Ashkin-Teller models on  $Z^2$ ," *J. Phys.* **A31**: 9055-9063; abstract online at <<http://citeseer.ist.psu.edu/chayes98percolation.html>> :

"For a region of the nearest neighbor ferromagnetic Ashkin—Teller spin systems on  $Z^2$ , we characterize the existence of multiple Gibbs states via percolation. In particular, there are multiple Gibbs states if and only if there exists percolation of any of the spin types. (i.e., the magnetized states are characterized by percolation of the dominant species.) This result was previously known only for the Potts models on  $Z^2$ ."

#DM Hake, R.R. 2007a. "Re: Winnie and Math," online at <<http://listserv.nd.edu/cgi-bin/wa?A2=ind0708&L=pod&P=R14667&I=-3>>. Post of 15 August to POD and other discussion lists:

Abstract: Hollywood actress Danica McKellar graduated summa cum laude from UCLA with a degree in math and coauthored the "Chayes-McKellar-Winn Theorem" on "Percolation and Gibbs state multiplicity for ferromagnetic Ashkin-Teller model on  $Z^2$ ." McKellar has been quoted thusly: "Nobody out there is saying that smart is sexy and smart is important. Role models like Paris Hilton have everything to do with why this country is being dumbed down. We need better PR." To that end McKellar has authored a book *Math Doesn't Suck: How to Survive Middle-School Math Without Losing Your Mind or Breaking a Nail*. But the book might better have been aimed at college graduates. Stanford's Jo Boaler – see Tri (2006) - has stated that girls and boys achieve at similar levels in mathematics through school and at the undergraduate level, but after college the numbers drop off. According to Stanford's Londa Schiebinger – see Tri (2006) - women earn 46 percent of undergraduate math degrees in this country but represent only 8 percent of math professors [Schiebinger may have meant math *full* professors – see Hale (2006)].

#DM Hake, R.R. 2007b. "Re: Winnie and Math: Girls' Math Scores Begin to Drop in Middle School?" online a <<http://listserv.nd.edu/cgi-bin/wa?A2=ind0708&L=pod&P=R17025&I=-3>>. Post of 19 Aug 2007 to POD and other discussion lists.

Responds to a post by Cathy Kessel (2007), President of the Association for Women in Mathematics <<http://www.awm-math.org/>>, who quotes data from National Assessment of Educational Progress and NCLB-induced data from California to dispute the advertisements for McKellar's (2007) book that "research continues to prove that it is in middle school when math scores begin to drop—especially for girls."

#DM Kessel, C. 2007. "Winnie and Math," RUME post of Aug 18 17:15:40 EDT 2007; online at <<http://tinyurl.com/6rjgyb>>.

Cathy Kessel, President of the Association for Women in Mathematics <<http://www.awm-math.org/>>, wrote (not to be construed as the official position of the AWM):

"The description of *Math Doesn't Suck* on the Amazon Web site states (in part):

\*\*\*\*\*

As the math education crisis in this country continues to make headlines, research continues to prove that it is in middle school when math scores begin to drop—especially for girls—in large part due to the relentless social conditioning that tells girls they ‘can’t do’ math, and that math is ‘uncool.’

\*\*\*\*\*

Where is this research about scores dropping ‘especially for girls’ in middle school?"

Kessel then quotes data from National Assessment of Educational Progress and NCLB-induced data from California to dispute the advertisements for McKellar's (2007) book that “research continues to prove that it is in middle school when math scores begin to drop—especially for girls,” and concludes: “I think girls should be encouraged in mathematics -- but I don't see that a gender gap in middle school test scores is the reason.”

RUME is a discussion list devoted to Research in Undergraduate Mathematics with archives at <[http://betterfilecabinet.com/pipermail/rume\\_betterfilecabinet.com/](http://betterfilecabinet.com/pipermail/rume_betterfilecabinet.com/)>. For a guide to discussion lists see “Over Sixty Academic Discussion Lists: List Addresses and URL's for Archives & Search Engines” [Hake (2007d)].

#DM McKellar, D. 2007. *Math Doesn't Suck: How to Survive Middle-School Math Without Losing Your Mind or Breaking a Nail*. Hudson Street Press. Amazon.com information at <<http://tinyurl.com/yrtxgd>>. Note the “Search Inside” feature.

#DM #SSG Trie, L. 2006. "Biases must be tackled to achieve gender equity in mathematics, scholars argue." *Stanford Report*, 15 February; online at <<http://news-service.stanford.edu/news/2006/february15/mathem-021506.html>>. Trie wrote Trie wrote (our *italics*):

A year after Harvard President Lawrence Summers' remarks suggesting innate gender differences in science and math ability, the Institute for Research on Women and Gender (IRWG) on Feb. 7 hosted an event titled "Proof and Prejudice: Women in Mathematics," to examine the culture of mathematics in this country and women's experience as professional mathematicians. . . . . Despite advances, unexamined biases remain within the culture of mathematics and science, Schiebinger said. "Many are held unconsciously by men and also by women—in university math departments as well as in our society in general," she added. . . . *Margot Gerritsen, a Stanford assistant professor of petroleum engineering who teaches mathematics, said there are no differences in ability between her male and female students.* "There are big differences ... in attitude and perception," she said. "I've seen much higher stress levels in women starting academic careers—about how they can contribute and fit in—than with the men." Male students are more likely to shrug off temporary setbacks, such as a poor test result, than women, she said. . . . Stanford Associate Professor of Education Jo Boaler. . . . [our insert – now at Sussex University in England as the Marie Curie professor in Education]. . . . ., an expert in mathematics education who spoke as a member of the audience, said elementary school teachers should not be blamed. *Girls and boys achieve at similar levels in mathematics through school and at the undergraduate level, she said.* "Girls are still achieving at very high levels across the board—that's the message that should go out there," she said. "The idea that they're not is damaging in its own right." But after college, she said, the numbers drop off. According to Schiebinger, women earn 46 percent of undergraduate math degrees in this country but represent only 8 percent of math professors... . [our insert - Schiebinger may have meant "math full professors" – see Hale (2006)]. . . . . Mathematics has a public relations problem in this country, particularly among some girls and women, according to Hollywood actress Danica McKellar. "Nobody out there is saying that smart is sexy and smart is important," said McKellar, the co-author of a mathematical proof. "Role models like Paris Hilton have everything to do with why this country is being dumbed down. We need better PR." . . . *Even women who make it as mathematicians often feel excluded from the broader culture,* said Claudia Henrion. . . [(1997)]. . . , author of *Women in Mathematics: The Addition of Difference*. In researching the book, a recurring theme arose, she said: "The women were very accomplished but they still felt as outsiders in the math community." The talent exists, Henrion said, so the question must be, "How do we cultivate it and how do we create communities in which it is maximized?"

Trie's report is featured in Rick Reis's (2006) "Proof and Prejudice: Women in Mathematics," and in the discussion list post by Hake (2006a).

#DM USA Today. 2007. "Person of the Week: Danica McKellar: 'Wonder Years' Actress Takes a Break From Hollywood to Do Some Math," 10 August, World News with Charles Gibson; online at <<http://abcnews.go.com/WN/PersonOfWeek/story?id=3467211&page=1>>.

## **H. Interactive Engagement #IE**

#IE \*Bruff, D. 2008. "Classroom Response Systems ('Clickers')," Vanderbilt Center for Teaching; online at <<http://tinyurl.com/6zhqk5>>; includes an extensive bibliography at <<http://tinyurl.com/3xcjkv>>.

#IE \*Caldwell, J.E. 2007. "Clickers in the Large Classroom: Current Research and Best-Practice Tips," *CBE—Life Sciences Education* 6(1): 9-20, Spring; online at <<http://www.lifescied.org/cgi/reprint/6/1/9.pdf>> (532 kB).

#IE \*Coletta, V.P., J.A. Phillips, & J.J. Steinert. 2007. "Interpreting force concept inventory scores: Normalized gain and SAT scores," *Phys. Rev. ST Phys. Educ. Res.* 3, 010106, Issue 1 – June; online at <<http://prst-per.aps.org/abstract/PRSTPER/v3/i1/e010106>>:

Abstract: "Preinstruction SAT scores and normalized gains  $G$  on the force concept inventory FCI . . . [our insert – Hestenes *et al.* (1992)]. . . were examined for individual students in interactive engagement IE courses in introductory mechanics at one high school  $N = 335$  and one university  $N = 292$ , and strong, positive correlations were found for both populations  $r = 0.57$  and  $r = 0.46$ , respectively. These correlations are likely due to the importance of cognitive skills and abstract reasoning in learning physics. . . . In prior research a strong correlation between FCI  $G$  and scores on Lawson's Classroom Test of Scientific Reasoning . . . [our insert - Lawson (1995)]. . . for students from the same two schools was observed. Our results suggest that, when interpreting class average normalized FCI gains and comparing different classes, it is important to take into account the variation of students' cognitive skills, as measured either by the SAT or by Lawson's test. While Lawson's test is not commonly given to students in most introductory mechanics courses, SAT scores provide a readily available alternative means of taking account of students' reasoning abilities. Knowing the students' cognitive level before instruction also allows one to alter instruction or to use an intervention designed to improve students' cognitive level."

#IE \*DeHaan, R.L. 2005. "The Impending Revolution in Undergraduate Science Education," *Journal of Science Education and Technology* 14(2): 253-269; abstract online at <<http://tinyurl.com/ymwwwe3>>.

ABSTRACT: "There is substantial evidence that scientific teaching in the sciences, i.e. teaching that employs instructional strategies that encourage undergraduates to become actively engaged in their own learning, can produce levels of understanding, retention and transfer of knowledge that are greater than those resulting from traditional lecture/lab classes. But widespread acceptance by university faculty of new pedagogies and curricular materials still lies in the future. In this essay we review recent literature that sheds light on the following questions:

- a. What has evidence from education research and the cognitive sciences told us about undergraduate instruction and student learning in the sciences?
- b. What role can undergraduate student research play in a science curriculum?
- c. What benefits does information technology have to offer?
- d. What changes are needed in institutions of higher learning to improve science teaching?

*We conclude that widespread promotion and adoption of the elements of scientific teaching by university science departments could have profound effects in promoting a scientifically literate society and a reinvigorated research enterprise. [Our italics.]*

#IE \*Dori, Y.J. & J. Belcher. 2004. "How Does Technology-Enabled Active Learning Affect Undergraduate Students' Understanding of Electromagnetism Concepts?" *The Journal of the Learning Sciences* **14**(2); online as a 1 MB pdf at <<http://tinyurl.com/cqoqt>>.

#IE \*Dreifus, C. 2007. "A Conversation With Eric Mazur: Using the 'Beauties of Physics' to Conquer Science Illiteracy," *New York Times*, 17 July, free online for a short time at <[http://www.nytimes.com/2007/07/17/science/17conv.html?\\_r=1&oref=slogin](http://www.nytimes.com/2007/07/17/science/17conv.html?_r=1&oref=slogin)>.

Copied into the Math-Teach archives at

<<http://mathforum.org/kb/thread.jspa?threadID=1597751&tstart=0>> by Jerry Becker.

#IE Froyd, J. 2007. "Evidence for the Efficacy of Student-active Learning Pedagogies," online at <<http://cte.tamu.edu/programs/scl.php>> (188 kB). The summary is:

"Although many resources have been published on improvements in student retention and/or learning as a result of using what can be referred to as student-active pedagogies, the resources are published in a variety of journals or on various websites. As a result, it may be difficult for an individual to locate and assemble these resources to support an argument in favor of using these alternative pedagogies. Over a period of eight years, including my time as the Project Director for the Foundation Coalition, one of the Engineering Education Coalitions supported by NSF, I have tried to assemble many of these resources in one place for easy reference."

#IE \*Gautreau, R. and L. Novemsky. 1997. "Concepts First-a Small Group Approach to Physics Learning," *Am. J. Phys.* **65**(5): 418-429; online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=65&Issue=5>>.

#IE \*Hake, R.R. 1998a. "Interactive-engagement vs traditional methods: A six thousand- student survey of mechanics test data for introductory physics courses," *Am. J. Phys.* **66**(1): 64-74; online at <<http://tinyurl.com/3xuyqe>> (84 kB).

#IE \*Hake, R.R. 1998b. "Interactive- engagement methods in introductory mechanics courses," online at <<http://tinyurl.com/2tg5d9>> (108 kB) - a crucial companion paper to Hake (1998a).

#IE Hake, R.R. 2000a. "What Can We Learn from the Physics Education Reform Effort?" ASME Mechanical Engineering Education Conference: *Drivers and Strategies of Major Program Change*, Fort Lauderdale, Florida, March 26-29; online at

<<http://www.physics.indiana.edu/~hake/ASME-040300e.pdf>> (436 kB); especially Section IC, p. 7, Silvia Plath in *The Bell Jar* (Harper & Row, 1971), p. 28-29 wrote (our *italics*):

*"The day I went into physics class was death ....A short dark man .....(held)... a little wooden ball. He put the ball on a steep grooved slide and let it run down to the bottom. Then he started talking about let a equal acceleration and let t equal time. And suddenly he was scribbling letters and numbers and equals signs all over the blackboard and my mind went dead. .....Well, I studied those formulas, I went to class and watched balls roll down slides and listened to bells ring and by the end of the semester most of the other girls had failed and I had a straight A....but I was panic-struck. Physics made me sick the whole time I learned it. What I couldn't stand was this shrinking everything into letters and numbers."*

#IE \*Hake, R.R. 2002a. "Lessons from the physics education reform effort," *Ecology and Society* 5(2): 28; online at <<http://www.ecologyandsociety.org/vol5/iss2/art28/>>. *Ecology and Society* (formerly *Conservation Ecology*) is a free online "peer-reviewed journal of integrative science and fundamental policy research with about 11,000 subscribers in about 108 countries." For an update on six of the lessons on "interactive engagement" see Hake (2007e).

#SV #IE Hake, R.R. 2002b. "Relationship of Individual Student Normalized Learning Gains in Mechanics with Gender, High-School Physics, and Pretest Scores on Mathematics and Spatial Visualization," submitted to the Physics Education Research Conference; Boise, Idaho; August 2002; online at <<http://www.physics.indiana.edu/~hake/PERC2002h-Hake.pdf>> (220 kB).

I found a gender-difference effect size for average normalized gains  $\langle g \rangle$  of 0.58 for an introductory mechanics course IU95S. Meltzer (2002) calculated gender-difference effect sizes of 0.44 and 0.59 for two classes [ $N = 59, 78$ ] at Iowa State University, but observed no significant gender difference in two other classes [ $N = 45, 37$ ] at Southeastern Louisiana University. . . . *the  $\langle g \rangle$  dependence on the gender 'hidden variable' is small relative to the very strong dependence of  $\langle g \rangle$  on the degree of interactive engagement (effect size 2.43)*. . . . "Therefore, in my opinion, **efforts to move traditional instruction more towards the interactive engagement for ALL students should receive a higher priority than concern for the apparently relatively small gender differences in test results discussed** by McCullough (2001) and Crouch & McCullough (2001).

#IE \*Hake, R.R. 2006b. "A Possible Model For Higher Education: The Physics Reform Effort (Author's Executive Summary)," *Spark* (American Astronomical Society Newsletter), June, online at <[http://www.aas.org/education/spark/SPARK\\_2006\\_06\\_June.pdf](http://www.aas.org/education/spark/SPARK_2006_06_June.pdf)> (1.9MB). Scroll down to pages 10 & 11 of the newsletter.

#IE \*Hake, R.R. 2007e. "Six Lessons From the Physics Education Reform Effort," *Latin American Journal of Physics Education* 1(1), September; online at <<http://journal.lapen.org.mx/sep07/HAKE%20Final.pdf>> (124 kB).

#LPE #IE \*Hake, R.R. 2007f. "Can Scientific Research Enhance the Art of Teaching?" invited talk, AAPT Greensboro meeting, 31 July, online at <<http://www.physics.indiana.edu/~hake/Sci&Art3.pdf>> (1.2 MB), and as ref. 50 at <<http://www.physics.indiana.edu/~hake/>>.

#IE \*Hake, R.R. 2007g. "A Conversation With Eric Mazur," AERA-L post of 23 Jul 2007 17:10:06-0700; online at <<http://tinyurl.com/2zo3pz>> :

Abstract: I discuss a recent New York Times report by Claudia Dreifus (2007) titled "A Conversation With Eric Mazur: Using the 'Beauties of Physics' to Conquer Science Illiteracy." During the conversation Mazur states: "I did what everyone else did: lectures. And the feedback was positive. . . . when I gave them . . . [the Halloun-Hestenes (HH) (1985a) concept-based exam]. . . about half had no clue as to what Newtonian mechanics were about." Mazur then shifted to "Peer Instruction," an interactive-engagement type of pedagogy that resulted in much larger pre-to-post test gains on the HH test. Are there valid and consistently reliable diagnostic tests of conceptual understanding in other disciplines (developed by experts in those disciplines), comparable to the HH test in physics, that might be used to gauge the need for, and the effects of, reform pedagogy? Yes, sources of references to high quality conceptual tests in Astronomy, Biology, Chemistry, Economics, Engineering, Geoscience, and Math are given for instructors who may wish to formatively assess the cognitive impact of their courses by means of pre/post testing.

#IE \*Hake, R.R. 2007h. "Mary Burgan's Defense of Lecturing," AERA-L post of 16 Feb 2007 22:05:16-0800; online at <<http://tinyurl.com/36rkjt>>. A response to "In Defense of Lecturing" [Burgan (2006)] - excepts from Burgan (2006) follow "Burgan;" my responses (slightly edited) follow "Hake."

Burgan: Pinker (1997). . . [a more recent edition is Pinker (1999)]. . . , in *How the Mind Works* criticizes the constructivists whose philosophy he describes as "a mixture of Piaget's psychology with counterculture and postmodernist ideology."

Hake: Pinker is evidently unaware of (a) the "Many Faces of Constructivism" [Phillips (1995)] and their relevance to mathematics education - see, e.g., "Re: Mathematics and Constructivism" [Hake (2001)]; and (b) the "knowledge based constructivism" of cognitive scientists Lauren Resnick and Megan Hall (1998).

Burgan: In the constructivist model, [Pinker] says "Children must actively construct mathematical knowledge for themselves in a social enterprise driven by disagreements about the meanings of concepts. The teacher provides the materials and the social milieu but does not lecture or guide the discussion. Drill and practice, the routes to automaticity, are called 'mechanistic' and seen as detrimental to understanding" [Pinker (p. 341-342 in the 1997 edition)]. Pinker, on the other hand, *believes that concepts have to be laid out, explained, and expounded.* [Our italics.]

Hake: Pinker's "constructivist model" is a straw man which, as far as we know, is not commonly found in classrooms and is not generally advocated by the math education community: e.g., Forman & Pufall (1988); diSessa (1988); Lochhead (1988); Heibert (1990); Schoenfeld (1992); Schoenfeld *et al.* (1998); NCTM (2000, 2006); Kilpatrick *et al.* (2001); Cohen & Ball (2001); Ball & Bass (2003); Izsak (2003); Hegedus & Kaput (2004); Ball *et al.* (2005); Bass (2005); Boaler (2008); Boaler & Staples (2008); USDE (2008). As for science education, perhaps Pinker could tell us how to "lay out, explain, and expound" the concepts of Newtonian mechanics so that students would demonstrate normalized pre-to-post test conceptual leaning gains comparable to those achieved by students benefiting from constructivist-type "interactive engagement."

#EB #IE \*Hake, R.R. 2007j. "Should We Measure Change? Yes!" online at <<http://www.physics.indiana.edu/~hake/MeasChangeS.pdf>> (2.5 MB), or as ref. 43 at <<http://www.physics.indiana.edu/~hake>>. To appear as a chapter in *Evaluation of Teaching and Student Learning in Higher Education*, a Monograph of the American Evaluation Association <<http://www.eval.org/>>. Therein I wrote (slightly edited):

"The Brain . . . Use It or Lose It . . . no matter what form enrichment takes, it is the challenge to the nerve cells that is important. Data indicate that passive observation is not enough; one must interact with the environment." [Marian Diamond (1996)]. *The superiority of IE methods in promoting conceptual understanding and higher-order learning is probably related to the "enhanced synapse addition and modification" induced by those methods.*

Cognitive scientists Bransford et al. (1999, 2000) stated: ". . . synapse addition and modification are lifelong processes, driven by experience. In essence, the quality of information to which one is exposed and the amount of information one acquires is reflected throughout life in the structure of the brain. This process is probably not the only way that information is stored in the brain, but it is a very important way that provides insight into how people learn."

Consistent with the above, the late biologist Robert Leamnson (1999, 2000) has stressed the relationship of biological brain change to student learning. In his first chapter "Thinking About Thinking and Thinking About Teaching," Leamnson (1999) defines teaching and learning thusly [our *italics*]

". . . teaching means any activity that has the conscious intention of, and potential for, *facilitation of learning in another. . . . learning is defined as stabilizing, through repeated use, certain appropriate and desirable synapses in the brain. . . .*"

And biologist James Zull (2003) in "What is The Art of Changing the Brain?" wrote [our *italics*]

"Although the human brain is immensely complicated, we have known for some time that it carries out four basic functions: getting information (sensory cortex,) making meaning of information (back integrative cortex), creating new ideas from these meanings (front integrative cortex,) and acting on those ideas (motor cortex). . . [for Zull's schematic of the brain see <<http://www.case.edu/artsci/biol/people/zull.html>>]. . . . From this I propose that there are four pillars of human learning: gathering, analyzing, creating, and acting. This isn't new, but its match the structure of the brain seems not to have been noticed in the past. *So I suggest that if we ask our students to do these four things, they will have a chance to use their whole brain.*"

For pro and con articles on the relevance of neuroscience to present-day classroom instruction see e.g., PRO: Lawson (2006) and Willis (2006); CON: Marchese (2002) and Bruer (1997, 2006). See also the commentary on Willis (2006) and Bruer (2006) by Hake (2006c) and Redish (2006).

#IE \*Hake, R.R. 2008a. "Design-Based Research in Physics Education Research: A Review," in *Handbook of Design Research Methods in Education: Innovations in Science, Technology, Engineering, and Mathematics Learning and Teaching* [Kelly, Lesh, & Baek (2008)]; a pre-publication version of Hake's chapter is online at <<http://www.physics.indiana.edu/~hake/DBR-Physics3.pdf>> (1.1 MB).

#IE \*Hake, R.R. 2008b. "Can Distance and Classroom Learning Be Increased?" *IJ-SoTL* 2(1): January; online at <<http://tinyurl.com/2t5sro>>.

The *International Journal of Scholarship of Teaching and Learning* (IJ-SoTL) <<http://www.georgiasouthern.edu/ijstol/>> is an open, peer reviewed, international electronic journal containing articles, essays, and discussions about the scholarship of teaching and learning (SoTL) and its applications in higher/tertiary education today.

#IE #CE \*Hake, R.R. 2008c. "Language Ambiguities in the Learning Sciences," submitted to the *Journal the Learning Sciences* on 4 March; online at <<http://www.physics.indiana.edu/~hake/LangAmbiguitiesC.pdf>> (2.1 MB) and as ref. 54 at <<http://www.physics.indiana.edu/~hake>>.

Contains a critique of "Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching" [Kirchner *et al.* (2006)].

#IE \*Hake, R.R. 2008e. "Re: Science education reform references?," online at <<http://tinyurl.com/4pvqqc>>. Post of 19 Jun 2008 15:20:21-0700 to AERA-J, AERA-L, Net-Gold, PhysLrnR, and POD.

ABSTRACT: Patti Thorn wrote "I need assistance locating references that identify the current status of science education reform -- specifically, the extent to which instructional change that includes use of strategies to engage students actively in classroom learning -- is taking place." Successful implementation of interactive engagement methods has been reported at Harvard, North Carolina State, MIT, Univ. of Colorado, and California Polytechnic at San Luis Obispo. Nevertheless, only a tiny fraction of introductory physics courses (and probably an even tinier fraction of other university introductory courses) appear to have departed from the traditional passive-student lecture mode, as bemoaned by University leaders such as Derek Bok, James Duderstadt, and Richard Cyert. Research on innovation diffusion (or lack thereof) of the type pioneered by Everett Rogers and Clayton Christensen, and now being undertaken in physics by Henderson & Dancy, might yield more information on the factors responsible for the pathologically slow diffusion of innovation in higher education.

For a compilation of responses to Thorn's post see "Summary of responses to locate science education reform references?" [Thorn (2008)].

**#IE** Kelly, A.E., R.A. Lesh, J.Y. Baek. 2008. "Handbook of Design Research Methods in Education: Innovations in Teaching." Routledge Education; publisher's information at <<http://tinyurl.com/4eazqs>>. Amazon.com information at <<http://tinyurl.com/4xsfgt>>.

"This *Handbook* presents the latest thinking and current examples of design research in education. Design-based research involves introducing innovations into real-world practices (as opposed to constrained laboratory contexts) and examining the impact of those designs on the learning process. Designed prototype applications (e.g., instructional methods, software or materials) and the research findings are then cycled back into the next iteration of the design innovation in order to build evidence of the particular theories being researched, and to positively impact practice and the diffusion of the innovation.

The *Handbook of Design Research Methods in Education* -- the defining book for the field -- fills a need in how to conduct design research by those doing so right now. The chapters represent a broad array of interpretations and examples of how today's design researchers conceptualize this emergent methodology across areas as diverse as educational leadership, diffusion of innovations, complexity theory, and curriculum research.

This volume is designed as a guide for doctoral students, early career researchers and cross-over researchers from fields outside of education interested in supporting innovation in educational settings through conducting design research."

**#IE** Lorenzo, M., C.H. Crouch, & E. Mazur. 2006. "Reducing the Gender Gap in the Physics Classroom," *American Journal of Physics* 74(2): 118-122; online at <<http://mazur-www.harvard.edu/publications.php?function=search&topic=9>>.

See also "Reducing the Gender Gap in the Physics Classroom: How sufficient is interactive engagement?" [Pollock *et al.* (2007)].

**#IE** \*Mahajan, S. & R.R. Hake. 2000. "Is it time for a physics counterpart of the Benezet/Berman math experiment of the 1930's?" *Physics Education Research Conference 2000: Teacher Education* <<http://www.sci.ccny.cuny.edu/~rstein/perc2000.htm>>; online at <<http://arxiv.org/pdf/physics/0512202>>, and as ref. 6 at <<http://www.inference.phy.cam.ac.uk/sanjoy/benezet/>>.

We suggest a K-12 science curriculum inspired by and compatible with the virtually forgotten pioneering work of Benezet (1935/36) [See the Benezet Centre <<http://www.inference.phy.cam.ac.uk/sanjoy/benezet/>>].

**#IE** \*Michael, J. 2006. "Where's the evidence that active learning works?" *Advances in Physiology Education* 30: 159-167, online at <<http://advan.physiology.org/cgi/content/full/30/4/159 - T1>>. A masterful review by a medical-education researcher/developer.

#IE Pollock, S.J., N.D. Finkelstein, & L. Kost. 2007. “Reducing the Gender Gap in the Physics Classroom: How sufficient is interactive engagement?,” *Phys Rev: ST Phys Ed. Res.* **3**, 010107 (2007); online at <<http://prst-per.aps.org/abstract/PRSTPER/v3/i1/e010107>>. The abstract is (our *italics*):

Previous research [“Reducing the Gender Gap in the Physics Classroom” (Lorenzo *et al.*, 2006)] demonstrated that the difference in performance between male and female students can be reduced and even eliminated, in consistent fashion, by using interactive engagement techniques in the introductory physics classroom. The present paper describes similar studies in a different, large research university and *finds that the use of interactive engagement techniques does not necessarily reduce the gender gap*. Furthermore, in the environments studied, there is a gap in learning gains between male and female students ( $p < 0.01$ ) whether partially or fully interactive classroom techniques are used. . . . [our insert - an informative statistic would have been the “effect size” and its comparison with the “interactive engagement” vs “traditional” effect size as was discussed in “Relationship of Individual Student Normalized Learning Gains in Mechanics with Gender, High-School Physics, and Pretest Scores on Mathematics and Spatial Visualization” [Hake (2002b)]. . . . Our findings suggest that engaging students in interactive educational environments is not sufficient to reduce the gender gap, and we find instances where despite significant learning gains by all students, the gender gap is increased. There is indication that there are both student and instructor effects that impact the gender gap, which are the subjects of ongoing studies.

#IE \*Smith, K.A., S. D. Sheppard, D.W. Johnson, & R.T. Johnson. 2005. “Pedagogies of Engagement: Classroom-Based Practices,” *Journal of Engineering Education* **94**(1): 87-102; online as a 492 kB pdf at <<http://tinyurl.com/y939x2>>. They write [our inserts at “. . . [insert]. . .”]:

“Research that has had a significant influence on the instructional practices of engineering faculty is Hake’s (1998a,b) comparison of students’ scores on the physics Force Concept Inventory (FCI), a measure of students’ conceptual understanding of mechanics, in traditional lecture courses and interactive engagement courses. The results shown for high school (HS), college (COLL), and university (UNIV) students in. . .[Fig. 1 of Hake (1998a)]. . . show that student-student interaction during class time is associated with a greater percent . . .[normalized]. . . gain on the FCI. Further study of the figure shows that even the best lectures. . .[more accurately the “best traditional courses” since *non-passive* student lectures such those by Mazur [Crouch & Mazur (2001)] yield relatively high normalized gains]. . . achieve student gains that are at the low end of student . . .[normalized]. . . gains in interactive engagement classes.”

#IE \*Thorn, P. 2008. “Summary of responses to locate science education reform references?” POD post of 20 Jun 2008 11:28:25 -0700; online at <<http://tinyurl.com/4a4m9b>> .

#IE \*Wieman, C. & K. Perkins. 2005. “Transforming Physics Education,” *Phys. Today* **58**(11): 36-41; online as a 292 kB pdf at <<http://tinyurl.com/4py56v>>. [Wieman is a 2001 Physics Nobelist.]

#IE Wieman, C. 2007. “Why Not Try a Scientific Approach to Science Education?” *Change Magazine*, September/October; online at <[http://www.cwsei.ubc.ca/resources/files/Wieman-Change\\_Sept-Oct\\_2007.pdf](http://www.cwsei.ubc.ca/resources/files/Wieman-Change_Sept-Oct_2007.pdf)> (804 kB). See also Wieman & Perkins (2005).

## I. International Comparisons #IC

#IC \*Bowen, S. 1998. "TIMSS - An Analysis of the International High School Physics Test,"

*APS Forum on Education Newsletter*, Summer 1998, pp. 7-10, online at

<<http://www.aps.org/units/fed/newsletters/aug98/timss2.html>> : Bowen wrote:

"In conversations with Dr. Senta Raizen of NCISE, who is one of the authors of the data analysis team for the TIMSS project, several important points came up that are not fully emphasized in the study reports. The major characteristic of the U.S. curricula is that they cover a very large number of topics and are primarily focused on vocabulary. Current U.S. students have been exposed to a very large number of topics, but do not have experience in depth on many. The various measures of student interest seem to continually drop with grade level in the U.S. Many other countries exhibit an increase in interest in science around the eighth grade where students go into some depth with various subjects. In the U.S. there is a more or less steady decrease in interest as the number of topics covered continues to increase. . . . My opinion of the TIMSS message for the physics community is that we need to take responsibility for pre-college physics and science teachers. We need to give them a better training in physics. I think the TIMSS results reflect the same effects as measured by the Force Concept Inventory. . . . [our insert - Hestenes *et al.* (1992), Hake (1998a,b; 2002a,b)]. . . in introductory mechanics classes. We are not generally giving students an understanding of physics which supports generalization and manipulation of concepts in new contexts."

#IC \*Campbell, G. 1997. "Raising Expectations," Review of *Aptitude Revisited: Rethinking Math and Science Education for America's Next Century* [Drew (1996)], *Issues in Science and Technology Online*, Spring; online at <<http://www.issues.org/13.3/campbe.htm>>. Campbell wrote (our *italics*):

"American children are learning more mathematics and science than they did 20 years ago. That's the good news. *The bad news is that what they're learning remains far from adequate and far less than their counterparts in virtually all of our competitor nations.* In *Aptitude Revisited: Rethinking Math and Science Education for America's Next Century*, David Drew. . .

[<<http://www.cgu.edu/pages/388.asp>>]. . . . professor of education and executive management at the Claremont Graduate School and director of Claremont's Education Program, plunges into the quagmire of U.S. education, valiantly sorting through the multidimensional problems that have our children locked in a pattern of underachievement and our college students abandoning the study of mathematics, science, and engineering. This slim volume efficiently catalogs the myriad, often contradictory, reform efforts of the past 20 years that have yet to realize their promise and ponders the inevitable impact of our enduring failure to prepare our young people for a technology-driven economy. The somewhat understated solution he proposes actually demands no less than a fundamental shift in our approach to education."

#IC \*DeHaan, R.L. & M. Hutcheson. 2007. "Teaching Innovation: Implications for India, China and America," *China Currents* 6(2); online at

<[http://www.chinacenter.net/China\\_Currents/spring\\_2007/cc\\_dehaan.htm](http://www.chinacenter.net/China_Currents/spring_2007/cc_dehaan.htm)>.

#EC #IC \* DeHaan, R.L. & K.M. Venkat Narayani, eds. 2008. *Education For Innovation Implications For India, China And America*. Sense, publisher's information at <<http://tinyurl.com/3l5jdb>>. The publisher writes (our *italics*):

*“In Education for Innovation: Implications for India, China and America,* distinguished thought leaders explore cutting-edge questions such as: Can inventiveness and ingenuity be taught and nurtured in schools and colleges? What are the most effective educational strategies to promote these abilities? How are vibrant economies driven by innovation? *What is the relationship between education for innovation and national competitiveness or economic development?* Focusing on the Worlds’ three most populous countries and largest economies, this book provides a forum for international experts to address a range of critically important issues related to higher education and its role in creating innovative societies.”

A free preview of pages 1-19 is online at

<<http://www.sensepublishers.com/catalog/files/9789087900731.pdf>> (668 kB)

**#IC** \*Bybee, R.W. & E. Sage. 2005. "No Country Left Behind: International comparisons of student achievement tell U.S. educators where they must focus their efforts to create the schools the country needs," *Issues in Science and Technology*, Winter, online at <<http://www.issues.org/21.2/bybee.html>>.

Rodger Bybee is executive director of the Biological Sciences Curriculum Study

<<http://www.bsces.org/>> in Colorado Springs, Colorado. Elizabeth Stage is director of the Lawrence Hall of Science <<http://www.lhs.berkeley.edu/>> at the University of California, Berkeley. Bybee & Sage give a cogent account of the PISA [Program for International Assessment <<http://nces.ed.gov/surveys/pisa/>>] and TIMSS [Trends in International Mathematics and Science Study <<http://nces.ed.gov/timss/>>] results as of 2005:

“Economic Time Bomb: U.S. Teens Are Among Worst at Math,” blared the December 7, 2004, *Wall Street Journal* headline over a story about the disheartening results of the latest international assessment of student achievement. The *New York Times* and *Washington Post* also carried major stories, albeit with slightly more temperate headlines. All the stories agreed that the results of the Program for International Assessment (PISA), which tested 15-year-olds from 41 countries, are cause for grave concern. *On the math section, the United States ranked 24th out of 29 member nations of the Organization for Economic Cooperation and Development (OECD), falling below Poland, Hungary, and Spain in the three years since the previous assessment.* (Our italics.) For a country that prides itself on its scientific and technological prowess, this seems disastrous. But is the situation as bad as the PISA test results indicates?

If we are to learn the relevant lessons from TIMSS we must begin by understanding how they differ from one another. TIMSS examines student performance and the background characteristics of students, teachers, and schools. Assessment items, which are developed through a consensus of representatives to the International Association for the Evaluation of Educational Achievement (IEA), are designed to link directly to the curricula of the participating countries. The TIMSS report thus specifies what students are expected to learn and how well they are learning it. . . . . PISA, developed by the OECD, has a different purpose. It measures literacy in reading, mathematics, and science in 15-year-olds. In mathematics, PISA assesses how well young adults can recognize and interpret mathematical problems in their world, translate problems into a mathematical context, and use mathematical knowledge and procedures to solve problems. Scientific literacy reflects students' ability to use scientific knowledge, to recognize scientific questions, and to relate scientific data to claims and conclusions. Students are also expected to communicate solutions effectively. PISA is not directly tied to the school curriculum but was conceived and designed to assess the practical outcomes of education systems. In other words, the PISA assessment aims to determine whether students not only have the knowledge they need but also the ability to use it to solve problems. Tests are administered to 15-year-olds, because that is typically the last year of compulsory schooling in participating countries.

#IC \*Elmore, R.F. 1997. "The Politics of Education Reform," *Issues in Science and Technology Online*, Fall, online at <<http://www.issues.org/14.1/elmore.htm>>. Elmore wrote (our *italics*) : "The recently released Third International Mathematics and Science Study (TIMSS), which made international comparisons of math and science performance among fourth- and eighth-grade students, strengthened the case of those who are calling for ambitious reform of U.S. education. U.S. fourth graders did relatively well in science and about average in math; eighth graders did slightly better than average in science and slightly below average in math. These findings are consistent with other assessments of U.S. student performance.

The TIMSS study also provided new and valuable information about the relationship between instructional practice and student performance. *The message to U.S. educators was clear: science and math education needs to be better focused and more rigorous.* Although one can still hear arguments that international comparisons are not fair, that the diversity of the U.S. population or the pluralistic nature of its political culture makes it impossible to replicate the coherence found in other countries' schools, or that U.S. schools are already improving at an acceptable pace, the reality is that the majority of the public, of elected officials, and of educators believe that change is needed. The task is to determine what changes are necessary to make a real difference to students and how reform can be achieved in the U.S. political culture. . . . .

In their profound analysis of the history of U.S. education reform, David Tyack and Larry Cuban. . . [Tyack & Cuban (1995)]. . . . note the persistent gap between what they call 'policy talk' and the world of daily decisions about what to teach, how to teach, and how to organize schools. Most reforms, they argue, exist mainly in the realm of policy talk - visionary and authoritative statements about how schools should be different, carried on among experts, policymakers, professional reformers, and policy entrepreneurs, usually involving harsh judgments about students, teachers, and school administrators. Policy talk is influential in shaping public perceptions of the quality of schooling and what should be done about it. *But policy talk hardly ever influences the deep-seated and enduring structures and practices of schooling, which I have called the 'instructional core' of school."*

**#IC #SDMA** Guiso, L., F. Monte, P. Sapienza, & L. Zingales. 2008. "Diversity: Culture, Gender, and Math - Analysis of PISA results suggests that the gender gap in math scores disappears in countries with a more gender-equal culture," *Science* **320**(5880): 1164 - 1165, 30 May; online to subscribers at <<http://tinyurl.com/5wwehg>>. An abstract is online at <<http://www.sciencemag.org/cgi/content/summary/320/5880/1164>>. The entire article is free online on the Math-Teach archives <<http://mathforum.org/kb/thread.jspa?threadID=1757413&tstart=0>>, thanks to Jerry Becker. [Becker's use of copyrighted material is in accord the "fair use" provision of the section 107 of the US Copyright Law – see e.g., <<http://www.law.cornell.edu/uscode/17/107.shtml>>.]

Mallow, J.V. 1993. "The Science Learning Climate: Danish Female and Male Students' Descriptions," *GASAT* **7** (1): 75-87. See GASAT#7 (1993)].

Mallow, J.V. 1994. "Gender-related Science Anxiety: A First Binational Study." *Journal of Science Education and Technology* **3**(4): 227-238; online to subscribers at <<http://www.springerlink.com/content/gqt46p10j78v510v/>>.

Mallow, J.V. 1995. "Students' Confidence and Teachers' Styles: A Binational Comparison," *Am. J. Phys.* **63**(11): 1007-1011; online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=63&Issue=11>>, abstract free to all.

Mallow, J.V. 1998. "Student Attitudes and Enrollments in Physics, with Emphasis on Gender, Nationality, and Science Anxiety," in J.H. Jensen, M. Niss, and T. Wedege, T., eds., *Justification and Enrollment Problems in Education Involving Mathematics or Physics*, Roskilde U. Press, Roskilde, DK: 237-258.

**#IC** \*Schmidt, W.H. & C. C. McKnight. 1998. "What Can We Really Learn from TIMSS?" *Science* **282**: 1830–1831; abstract online at <<http://www.sciencemag.org/cgi/content/summary/282/5395/1830?ck=nck>> : "Important policy implications regarding American mathematics and science education are available through the results of the Third International Mathematics and Science Study (TIMSS). This is especially true if the results from all parts of the study including those pertaining to curriculum and instructional practices are combined with those related to the achievement testing in grades three, four, seven, eight and the end of secondary school. The decline in relative standing for the U.S. from grade four to grade 12 in both mathematics and science achievement is clear as are the corresponding differences in intellectual rigor in the U.S. curriculum as compared to that of the top achieving countries, especially during the middle and high school years."

**#IC** \*Schmidt W.H, S. Raizen , E.D. Britton, L.J. Bianchi, R.G. Wolfe. 1997. "*Many Visions, Many Aims (TIMSS Volume 3) - A Cross-National Investigation of Curricular Intention.*" Springer. Amazon.com information at <<http://tinyurl.com/cpk59>>.

#IC \*Schmidt, W.H., C.C. McKnight, & S.A. Raizen. 1997. "A Splintered Vision: An Investigation of U.S. Science and Mathematics Education." Amazon.com information at <<http://tinyurl.com/4vopby>>. Executive summary online at <<http://ustimss.msu.edu/splintrd.htm>>.

#IC \*Schmidt W.H., C.C. McKnight, R.T. Houang, H.C. Wang, D. Wiley, L.S. Cogan, R.G. Wolfe. 2001. "*Why Schools Matter: A Cross-National Comparison of Curriculum and Learning.*" Jossey-Bass. Amazon.com information at <<http://tinyurl.com/7esac>>.

#IC \*Valverde, G.A. & W.H. Schmidt, 1997-98. "Refocusing U.S. Math and Science Education: International comparisons of schooling hold important lessons for improving student achievement" *Issues in Science and Technology Online*, Winter: <<http://bob.nap.edu/issues/14.2/schmid.htm>>.

#IC \*Valverde, G.A., L.J. Bianchi, R.G. Wolfe, W.H. Schmidt, R.T. Houang. 2002. "*According to the Book: Using TIMSS to Investigate the Translation of Policy to Practice Through the World of Textbooks.*" Kluwer. Amazon.com information at <<http://tinyurl.com/bodpu>>.

### **J. Introductory Physics Curriculum S (for Synthesis) #IPCS**

#IPCS \*Ford, K.W. 1987. "Guest Editorial: Whatever Happened to *Curriculum S?*" *Phys. Teach.*, March, pp. 138-139; online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=PHTEAH&Volume=25&Issue=3>>. [Pages 138-139 are currently missing from the March 1987 online issue, but we have been assured by the AAPT that they will soon be added.] Ford wrote (our *italics*):

"From the . . . second Ann Arbor Conference, November 1962 - came a succinct and memorable recommendation: that two kinds of curricula for physics majors be developed (to meet the needs of two kinds of students). These were named curriculum R and curriculum S. Curriculum R (for Research) was the then-current (and still dominant) undergraduate curriculum, whose principal aim is to prepare students for graduate study. *Curriculum S (for Synthesis) was to serve students who wanted to study physics as background for something other than physics research: business, law, medicine, teaching, some other scientific study, or just informed citizenship.* What has happened? Sad to say, nothing. Curriculum R was already strong and is still strong. *Curriculum S did not exist then and it does not exist now* (in first approximation). . . . *It is time to look again at Curriculum S . . . We need majors with aspirations other than physics research. Ours is an exciting field, a central part of the liberal arts. It provides a useful background for many activities. Should we not promote its serious study by future teachers, lawyers, and business people? Above all, we need a physics major program suitable for (and attractive to) some of the teachers of the next generation - not just high-school physics teachers, but elementary and middle school teachers as well.*"

#IPCS \*Hake, R.R. 2000b. "Is it Finally Time to Implement Curriculum S?" *AAPT Announcer* 30(4): 103; online at <<http://www.physics.indiana.edu/~hake/CurrS-031501.pdf>> (1.2 MB) – 400 references & footnotes, 390 hot-linked URL's.

This paper concerns improving the education of undergraduate physics majors by instituting a "Curriculum S" for "Synthesis." But because that's a small part of a much larger educational problem in the U.S. there's a lot of material on the reform of P-16 education generally (P = preschool). A large number of references

#IPCS \*Jossem, E.L. 1964, "Undergraduate Curricula in Physics: A Report on the Princeton Conference on Curriculum S," *Am. J. Phys.* 32(6): 491–497, online at

<<http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=32&Issue=6>> :

Abstract: Starting with the recommendations of the Second Ann Arbor Conference on two distinct undergraduate physics major programs, R and S. . . . [our insert – "R" for Research and "S" for Synthesis]. . . , the Princeton Conference on Curriculum S continued the consideration of the conceptual and practical problem of providing appropriate instruction in physics to undergraduate majors having a variety of educational goals. Major discussion was concerned with the nature of Curriculum S and its relation to R, with the desirability of providing more open curricular structures, and with the problems of obtaining an optimum mixture of elements of analysis and synthesis in intellectually vigorous courses. Several sample skeleton outlines of possible curricula were produced by Conference working groups, and it is expected that progress in developing the working materials for the S curriculum will be continued.

#IPCS \*Lindenfeld, P. 2001. "We can do better: A Report on Some Teaching Innovations," Forum on Physics and Society Newsletter, July; online at <<http://www.aps.org/units/fps/newsletters/2001/july/701art1.pdf>> (16 kB): Lindenfeld wrote (our *italics*):

"At Rutgers University we are trying to address several of the major problem areas: the declining number of physics majors, the dissatisfaction with the introductory courses, the barrier that physics courses represent for students who are not well prepared, the often marginal support system that we provide for our students, and the neglect of these problems by many members of the faculty. We have the normal physics major curriculum with standard courses and provision for honors projects. It provides excellent preparation for graduate school. *If this 'professional' major were our only one, we would have of the order of ten graduates per year, as is true for comparable institutions.* [Our *italics*.] Some decades ago we added the 'general' major, with a less demanding curriculum, based on the premise that we can provide substantive science-based education to students who do not intend to pursue a research career in physics. . . .[our insert – 'Curriculum S'?]. . . This . . . (the 'general major,' two new full year post-introductory courses, a 5-year program in conjunction with the College of Engineering, and an applied physics major). . . *puts us in the rarified range of 45 graduating seniors this year . . .* Our efforts have to continue, for the sake of the students, and for our own. We can do better!"

See also "Lessons learned: A case study of an integrated way of teaching introductory physics to at-risk students at Rutgers University" [Etkina *et al.* (1999)].

#IPCS \*Lindenfeld, P. 2002. "Guest Comment: Format and content in introductory physics," *Am. J. Phys.* **70**(1): 12-13; online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=70&Issue=1>>.

## **K. Is There a Female Science? – Pro & Con #FSP, #FSC**

#FSC #CS Almeder, R.F., N. Koertge, & C.L. Pinnick, eds. 2003. *Scrutinizing Feminist*

*Epistemology: An Examination of Gender in Science*. Rutgers University Press; publisher's information at <<http://tinyurl.com/4u883j>> Amazon.com information at <<http://tinyurl.com/29rtf4>>:

Book Description (our *italics*):

This volume presents the first systematic evaluation of a feminist epistemology of science's power to transform both the practice of science and our society. Unlike existing critiques, *this book questions the fundamental feminist suggestion that purging science of alleged male biases will advance the cause of both science and by extension, social justice.*

The book is divided into four sections: the strange status of feminist epistemology, testing feminist claims about scientific practice, philosophical and political critiques of feminist epistemology, and future prospects of feminist epistemology. Each of the essays - most of which are original to this text - directly confronts the very idea that there could be a feminist epistemology or philosophy of science. Scrutinizing Feminist Epistemology provides a timely, well-rounded, and much needed examination of the role of gender in scientific research.

#FSP Auchincloss, P. 1998. "Physics and Feminism," *APS News*, May; online (for APS members)

at <<http://www.aps.org/publications/apsnews/199805/backpage.cfm>>. Auchincloss wrote:

"These feminist studies. . . [our insert - as discussed previously by Auchincloss: Evelyn Fox Keller, Helen Longino, and Donna Haraway]. . . . of science do not describe a different science . . . [our insert - most contributors to Koertge (1998) would probably disagree] - certainly not a 'feminine science' - but they shift the emphasis so that we see the importance, even necessity, of diversity among scientists. Moreover, they improve on more traditional accounts of science by explaining both its achievements and its lapses. As part of a strategy for increasing the proportion of women in science, feminist studies raise issues of women and science as intellectual questions within the academy, rather than pushing them to the margins of institutional life. And feminist studies undoubtedly challenge our underlying assumptions about the making of men, women, and science. Thus, feminist studies of science may hold a key to the success of efforts to attract and retain women in physics, to create gender equitable environments in physics departments, and to reform physics education. Bringing together physics and feminism - allowing physics to become more feminist - has potential to bring about positive change in the culture of physics and realize a truly diverse physics community."

See the responses by Kilty *et al.* (1998).

#FSP Barr, J., & L.I. Birke. 1998. *Common Science?: Women, Science And Knowledge*. Indiana University Press, publisher's information at

<[http://www.iupress.indiana.edu/catalog/product\\_info.php?products\\_id=20721](http://www.iupress.indiana.edu/catalog/product_info.php?products_id=20721)>. Amazon.com information at <<http://tinyurl.com/25cyp2>>. Note the "Search Inside" feature.

#FSP Bleier, R. 1988. *Feminist Approaches to Science*. Pergamon Press. Amazon.com information at <<http://tinyurl.com/347nph>>. According to the *Wisconsin Academy Review* 46(1) [Winter 1999-2000] <<http://tinyurl.com/5bo3yk>> :

“Ruth Bleier was a pioneer faculty member who achieved international recognition as a neuroanatomist while ‘leading two lives’ on the Madison campus. Her second life had a significant influence on the University of Wisconsin-Madison and beyond when she helped develop the Women’s Studies Program in 1975. Bleier was a graduate of the Women’s Medical College of Pennsylvania. After practicing medicine in Baltimore for eight years, she changed her career, training at Johns Hopkins University to become a neuroanatomist. She joined the faculty of the University of Wisconsin-Madison in 1967 and worked at both the Waisman Center and the Primate Center---leading her to develop an interdisciplinary orientation. While achieving fame for her studies of the mammalian hypothalamus, she also worked throughout her career in the area of political and social bias in science. Bleier’s research with the Department of Neurophysiology *led her to recognize gender-related brain structures* [our *italics*], and she became an authority on the organization of the mammalian hypothalamus. After establishing great credibility as a ‘hard-core’ scientist, she became a revered leader in the field of feminist approaches to the sociology of scientific knowledge.”

A list of books by Ruth Bleier is online at <[http://isbndb.com/d/person/bleier\\_ruth.html](http://isbndb.com/d/person/bleier_ruth.html)>.

#FSP Creager, A., E. Lunbeck, & L. Schiebinger, eds. 2001. *Feminism in Twentieth-Century Science, Technology, and Medicine*. University of Chicago Press, publisher’s information at <<http://www.press.uchicago.edu/cgi-bin/hfs.cgi/00/14325.ctl>> :

“The essays in this volume explore how feminist theory has had a direct impact on research in the biological and social sciences, in medicine, and in technology, often providing the impetus for fundamentally changing the theoretical underpinnings and practices of such research.”

#FSP Haraway, Donna. 2005. Homepage at UC- Santa Cruz,  
<<http://feministstudies.ucsc.edu/facHaraway.html>>.

#FSP Haraway, D. 1990. *Primate Visions: Gender, Race, and Nature in the World of Modern Science*. Routledge. Amazon.com information at <<http://tinyurl.com/43gvyp>>.

#FSP Haraway, D. 1991. *Simians, Cyborgs, and Women: The Reinvention of Nature*. Routledge. Amazon.com information at <<http://tinyurl.com/4mdkky>>. Note the “Search Inside” feature.

#FSP Harding, S. 1986. *The Science Question in Feminism*. Cornell University Press. Amazon.com information at <<http://tinyurl.com/3e5k9s>>. Note the “Search Inside” feature. For comments on Harding’s standpoints see e.g., *Science and Anti-Science* [Holton (1993)], *A House Built on Sand: Exposing Postmodern Myths About Science* [Koertge (1998)], and *What Makes Nature Tick?* [Newton (1997)].

#FSP Harding, S. 1992. "Why Physics Is a Bad Model of Physics," in R.Q. Elvee, ed., *The End of Science? Attack and Defense*. University Press of America, publisher's information at <<http://www.univpress.com/Catalog/Flyer2.shtml?SKU=0819184896>>. See comments by Holton (1993). Amazon.com information at <<http://tinyurl.com/yswbrc>>:

Book Description: The title "The End of Science?" asks not whether science itself is about to end or even to wane, but whether people will stop claiming that science knows nature as it is. Science, it suggests, may know nature only as the scientist sees it. Or the title suggests that, in knowing nature, scientists to some extent create nature. No one bothers to ask philosophers or theologians, poets, or politicians, workers or bosses whether they know the world as it is. It is common knowledge that the world for which they speak has been affected already by their description of that world. Will not the same fate strike scientists now? Has it not already? This is the basic issue that the six distinguished contributors address. They include Sandra Harding, Sheldon Lee Glashow, Ian Hacking, Mary Hesse, Gerald Holton, and Gunther S. Stent. Co-published with the Nobel Conference.

#FSP Harding, Sandra. 2008. Homepage at New York University, <<http://www.gseis.ucla.edu/faculty/members/harding>>.

#FSP Harding, S. 1998. *Is Science Multicultural? Postcolonialisms, Feminisms, and Epistemologies*. Indiana University Press, publishers information at <[https://www.iupress.indiana.edu/catalog/product\\_info.php?isbn=0-253-21156-5](https://www.iupress.indiana.edu/catalog/product_info.php?isbn=0-253-21156-5)>. According to Indiana University Press:

"Noted theorist Sandra Harding explores what practitioners of European/American, feminist, and postcolonial science and technology studies can learn from each other. All three provide accounts of the history and practice of sciences which are alternative to the standard account of the Enlightenment Dream. These accounts require radical revision in conventional philosophies of science."

The first chapter is online at <[http://www.havenscenter.org/files/Harding\\_3.pdf](http://www.havenscenter.org/files/Harding_3.pdf)> (1.3 MB).

#FSC Holton, G. 1993. *Science and Anti-Science*. Harvard University Press, publisher's information at <<http://www.hup.harvard.edu/catalog/HOLSCI.html>>. See especially Chapter 6: "The Anti-Science Phenomenon." Holton wrote:

"A fourth group... (who oppose what they conceive of as a hegemony of science-as-done-today in our culture)... is a radical wing of the movement represented by such writers as Sandra Harding who claims that physics today 'is a poor model [even] for physics itself' (Harding 1992). For her science now has the fatal flaw of 'androcentrism'; that, together with faith in the progressiveness of scientific rationality, as brought us to the point where, she writes: 'a more radical intellectual, moral, social, and political revolution [is called for] than the founders of modern Western cultures could have imagined' (Harding 1986). One of her like-minded colleagues goes even further, into the fantasy that science is the projection of Oedipal obsessions with such notions as force, energy, power, or conflict."

#FSC Hornig, L. 1987. “Gender and science,” *GASAT* 4 (1987). This paper, which challenged the then nascent claims from some feminists that science was intrinsically inappropriate for women, and that is why they avoided it, has been rarely cited. Hornig wrote:

“...although it is true that the concentration of women in most science fields is below one-third, compared to about one-half in the humanities, the numbers of women scientists far exceed those of women humanists. Thus, among the total current stock of Ph.D.s in this country, there are about 63,000 women scientists and about 27,000 women humanists, or a ratio of 2.33. The ratio of new women Ph.D.s in sciences to those in humanities in 1985 stood at 3.44, so that the disparity is growing just as it has among men. The fields regarded as least congenial to women – physical and mathematical sciences—produced over 900 doctorates in 1985, contrasted with about 630 in the so-called traditional fields of English and other modern languages.... more women have been Nobel laureates in the sciences than in either literature or peace endeavors.... When we compare women to men, determining the relative proportions of each sex in various activities, we see great inequalities. When we compare women in one field to those in another, determining how they distribute themselves among the choices open to them, we discover two things: the patterns of choice resemble those of men, and the disadvantages women face are essentially invariant across fields. In short, women face some discrimination in all careers *because they are women*, not because they are unsuited to science or science to them.” [Italics in the original.]

#FSC Howard, S. 2000. “Science Has No Gender,” *STATUS*, January; online at <[http://www.aas.org/cswa/status/status\\_jan00.pdf](http://www.aas.org/cswa/status/status_jan00.pdf)> (256 kB):

“For over 4,000 years the historical record has, now and then, included scientists, engineers, and natural philosophers. For over 4,000 years there have been women in that list just as there have been men. Who would have thought it? It’s true. Science is as traditional a role for women as it has been for men. . . . The people who can combine the sensible chunks into useful solutions are scientists and engineers. Scientists do tend to share certain attributes: luck, intelligence, education, ability, courage, and sweat. There is no gender lurking in these features. None. THE RESULTS OF SCIENCE HAVE NO GENDER. . . .With the help of Dr. Deborah Crocker at the University of Alabama we created a web page . . . (Astronomy Program. 2002). . . with all the details.” (EMPHASIS in the original.)

#FSP Keller, Evelyn Fox. 2008. Homepage at MIT

<[http://web.mit.edu/sts/faculty/info/Keller\\_Evelyn-css.html](http://web.mit.edu/sts/faculty/info/Keller_Evelyn-css.html)>.

#FSP Keller, E.F. & H.E. Longino, eds. 1996. *Feminism & Science*. Oxford University Press. Amazon.com information at <<http://tinyurl.com/3nko7j>>. Note the “Look Inside” feature.

#FSP Keller, E.F. 1996. *Reflections on Gender and Science*. Tenth Anniversary Paperback Edition. Yale University Press; publisher’s information at <<http://yalepress.yale.edu/yupbooks/book.asp?isbn=0300065957>>. A Google “preview” is online at <<http://tinyurl.com/4yd76y>>.

For commentary on Keller’s position see, e.g., *What Makes Nature Tick?* [Newton (1997, pages 27 and 209)]; and the index entries for “Keller” in *A House Built on Sand: Exposing Postmodern Myths About Science* Koertge (1998).

#FSC #FSP Kilty, K. T., K. Allen, D. Pushkin, C. Barker, E. Finkel. 1998. "Reader Responses to 'Physics and Feminism,' May 1998 by Priscilla Auchincloss," *APS News*, July, online at <<http://www.aps.org/publications/apsnews/199807/back-page.cfm>>. [See Auchincloss 1998.] Respondent Crystal Barker wrote:

"Physics, more feminist? Physics does not need to be more anything - except appreciated. It certainly does not need to be more feminist. Yes, I have encountered bias from males in physics, as well as the occasional derogatory remark or tasteless comment. But one should be careful not to confuse the science with the scientist. Auchincloss tells us that the group provides 'criticism or approval, and the paradigm to allow integration of the various parts of the puzzle.' So now objectivity is a paradigm, and not a primary assumption? Is she trying to explicate the scientific method and concomitant practice of peer-review? If so, she's done a poor job. Coupling it in the language of feminist rhetoric lessens the impact of the power of reproducibility. Reproducibility means that when I make an observation, you can make the same observation independently, whether you like me or not, agree with my lifestyle, philosophy, or gender. This is where science derives its power and beauty. There is nothing exclusionary or oppressive here. *I think Auchincloss' energies would be better spent improving the overall quality of physics education.* This way, when an argument is lost due to lack of knowledge, no one need cry 'sex discrimination' or worse, 'old boy network.'

 (Our *italics*.)

#FSC #CS Koertge, N. ed. 1998. *A House Built on Sand: Exposing Postmodern Myths About Science*. Oxford University Press, publisher's information at <<http://tinyurl.com/3824km>>.

For anti-postmodernist comment on the work of Ruth Bleier, Donna Haraway, Sandra Harding, Evelyn Fox Keller, Helen Longino, and Londa Schiebinger see the corresponding index headings. For a more recent book in this vein see *Scrutinizing Feminist Epistemology: An Examination of Gender in Science* [Almeder *et al.* (2003)].

The back cover of Koertge (1998) carries a testimonial from Dudley Herschbach (1986 Chemistry Nobelist): "Critics as well as admirers of science will find in these essays much that deserves to be taken to heart, head, and hearth. Large wings of the rambling postmodern house suffer from shoddy work and rambling footing. This should help both cultural scholars and scientists to find bedrock for sturdy construction rather than cynical deconstruction."

#FSP Longino, Helen. 2004. Homepage at the University of Minnesota, <<http://www.philosophy.umn.edu/people/faculty/longino.html>>.

#FSC Markowitz, D. 2000. "My Opinion - Others May Differ: Who Wears Pythagoras' Trousers?" *APS News*, March; online (for APS members) at <<http://www.aps.org/publications/apsnews/200003/markowitz.cfm>>. Markowitz wrote :  
"The book is *Pythagoras' Trousers: God, Physics, and the Gender Wars*. . . . (Wertheim 1997). . . . The title reminds us that Pythagoras and his followers combined natural and supernatural studies. They originated the idea God is a mathematician, an idea that still has currency. The author covers much of the history of Western science, religion, and society, and she does so with a deft hand. Her main points are that women have been deliberately excluded from the highest callings of the mind, encompassing both science and religion, and that the persistence of this situation bodes ill for science, for society, and for women. In the introductory chapter Wertheim zooms in on the most egregious religion and the most offending science by saying: 'Physics is thus the Catholic Church of science'. . . .' A good deal of Wertheim's argument is that male physics and female physics are different, and, being different, it would be beneficial to have both. It is a yin/yang kind of thing. But is it so?"

#FSP McCullough, L. 2002. "Women in Physics: A Review," *The Physics Teacher* 40(2): 86-91, online at to subscribers at  
<<http://scitation.aip.org/dbt/dbt.jsp?KEY=PHTEAH&Volume=40&Issue=2>>.

McCullough wrote:

"The widely used *Force Concept Inventory*. . . [our insert - Hestenes *et al.* (1992)]. . . mentions rockets, hockey pucks, and cannon balls, contexts with which men are typically more comfortable than women. These male oriented contexts may be negatively affecting women's scores . . . Researchers studying the theoretical underpinnings of the nature of science itself [Keller 1985, Bleier 1988, Schiebinger 1999] suggest that *the very nature of science itself and the scientific method is inherently masculine*, which can serve as a barrier to women." (Our *italics*.)

For commentary on Keller (1985) see, e.g., *What Makes Nature Tick?* [Newton (1997, pages 27 and 209)], and the index entries for "Keller" in *A House Built on Sand: Exposing Postmodern Myths About Science* [Koertge (1998)]. For commentary on Schiebinger (1999) see e.g., index entries for "Schiebinger" Koertge (1998)].

#FSP McCullough, L. 2004. "Gender, Context, and Physics Assessment," *Journal of International Women's Studies, Special Issue: Women in Science* 5(4), May; online at  
<[http://www.bridgew.edu/SoAS/jiws/May04\\_Special/Gender.pdf](http://www.bridgew.edu/SoAS/jiws/May04_Special/Gender.pdf)> (92 kB). McCullough wrote:

"The issues surrounding women and science have been much discussed over the last few decades. These discussions have taken many forms. One branch has been the dialogue about the masculine nature of science and how that has affected women's participation in science and the growth of science itself. Londa Schiebinger (1999) gathers much of this debate together in her book "Has Feminism Changed Science?" Science, particularly the 'hard' sciences such as chemistry and physics, are typically thought of as being objective, unbiased. Historically, it has not been considered that who does the science might affect the science itself. Yet Schiebinger, Evelyn Fox Keller, and others suggest that this is not the case. Throughout history women have been excluded from science via many different means. The lack of women in science has led to masculine theories and interpretations."

#FSC #CS \*Newton, R. 1997. *The Truth of Science: Physical Theories and Reality*. Harvard University Press, publisher's information at

<<http://www.hup.harvard.edu/catalog/NEWTRU.html>> :

"To claims that science is a social construction, Newton answers with the working scientist's credo: 'A body of assertions is true if it forms a coherent whole and works both in the external world and in our minds.' The truth of science, for Newton, is nothing more or less than a relentless questioning of authority combined with a relentless striving for objectivity in the full awareness that the process never ends. With its lucid exposition of the ideals, methods, and goals of science, his book performs a great feat in service of this truth."

#FSP Schiebinger. L. 1989. *The Mind Has No Sex? Women in the Origins of Modern Science*. Harvard University Press, publisher's information at

<<http://www.hup.harvard.edu/catalog/SCHMIN.html>>.

#FSP Schiebinger, L. 2001. *Has Feminism Changed Science?*. Harvard University Press; publisher's information at <<http://www.hup.harvard.edu/catalog/SCHHAS.html>>.

#FSP Schiebinger, L. 2004. *Nature's Body: Gender In The Making Of Modern Science*. Rutgers University Press, 2<sup>nd</sup> edition. Amazon.com information at <<http://tinyurl.com/3aeht6>>. Note the “Search Inside” feature.

#FSP Schiebinger, L. ed. 2008. *Gendered Innovations in Science and Engineering*. Stanford University Press, publisher’s information at <[http://www.sup.org/book.cgi?book\\_id=5814%205815%20](http://www.sup.org/book.cgi?book_id=5814%205815%20)>.

The introduction “Getting more Women in to Science: Knowledge Issue” is online at <[http://www.stanford.edu/group/gender/People/schiebinger\\_sg.pdf](http://www.stanford.edu/group/gender/People/schiebinger_sg.pdf)> (160 kB).

#FSP Schiebinger, Londa. 2008. Homepage at Stanford <<http://www.stanford.edu/dept/HPST/schiebinger.html>>.

#FSC Tobias, S., M. Urry, & A. Venkatesan. 2002. “Physics: For Women, the Last Frontier, editorial, *Science* 296: 5571; online at <<http://www.sciencemag.org/cgi/content/summary/296/5571/1201>>. Report on the International Union of Pure and Applied Physics (IUPAP)-sponsored international conference on women in physics held 7 to 9 March 2002 in Paris <<http://www.if.ufrgs.br/~barbosa/conference.html>>. Tobias *et al.* report [our *italics*]:

*Neither the speakers in the formal sessions nor the delegates entertained the postmodernist position that without women, science must be biased.* Rather, the distinction was drawn between the conduct of science and the behavior of scientists, in this case physicists. To be sure, women need to better understand the mechanisms of hiring, funding, and promotion; that is, how to play the game. But the game itself has to be purged of cloning, patronage, and outright discrimination if transparency in hiring and promotion is to become the rule. ‘Excellent men have nothing to fear from transparency,’ concluded a French delegate.

[See also the reports in *Physics Today* by Feder (2002) and in *APS News* (2002a).

#FSP Tuana, N. 1989. *Feminism and Science*. Indiana University Press, publisher’s information at <[http://www.iupress.indiana.edu/catalog/product\\_info.php?products\\_id=21618](http://www.iupress.indiana.edu/catalog/product_info.php?products_id=21618)>:

“Questioning the objectivity of scientific inquiry, this volume addresses the scope of gender bias in science. The contributors examine the ways in which science is affected by and reinforces sexist biases. The essays reveal science to be a cultural institution, structured by the political, social, and economic values of the culture within which it is practiced.”

#FSP Weiler, K. 1988. *Women Teaching For Change: Gender, Class and Power*. Bergan & Harvey. Amazon.com information at <<http://www.amazon.com/Women-Teaching-Change-Critical-Education/dp/0897891287>>. Note the “Search Inside” feature.

**#FSP** Weiler, K. ed. 2001. *Feminist Engagements: Reading, Resisting, and Revisioning Male Theorists in Education and Cultural Studies*. RoutledgeFalmer. Amazon.com information at <<http://tinyurl.com/55dp9n>>.

PRODUCT DESCRIPTION: *Feminist Engagements* is a collection of original essays by some of the top names in feminist education, in which they read, resist and revision the works of the major twentieth-century theorists in education and cultural studies. These essays provide an excellent feminist introduction to such important scholars as John Dewey, W.E.B. Dubois, Michel Foucault, Stuart Hall, Paulo Freire, and Antonio Gramsci. Contributors include: Patti Lather, Alice Pitt, Jane Kenway, Annette Henry, Madeleine Arnot, among others.

**#FSP** Wertheim, M. 1997. *Pythagoras' Trousers: God, Physics, and the Gender Wars*. Norton. Amazon.com information at <<http://www.amazon.com/Pythagoras-Trousers-Physics-Gender-Wars/dp/0393317242>>. Note the “Search Inside” feature. [See the review by Markowitz (2000).] From the back cover:

Why are there so many physics books with “God” in their titles? In *Pythagoras’ Trousers* Margaret Wertheim argues that from its inception physics has been a religiously inspired activity – a science based on a conception of God a divine mathematical creator. In this highly accessible book, she offers an astute cultural and social history from ancient Greece to our own time. Moreover, Wertheim suggests that the priestly culture of physics has served throughout the ages as a powerful barrier to the entry of women.

## **L. Schools Shortchange Girls (or is it Boys)? #SSG , #SSB**

#SSG AAUW. 1992. *How Schools Shortchange Girls: The AAUW Report* , online at:

< <http://www.aauw.org/research/schoolsShortchange.cfm> >. An executive summary is online at < <http://www.aauw.org/research/upload/hssg.pdf> > (340 KB).

Agreeing with the AAUW report is:

- (a) *Failing At Fairness: How Our Schools Cheat Girls* [Sadker & Sadker (1995)], and
- (b) “Seeing Gender” [Spears (2008)].

Disagreeing with AAUW report is:

- (c) “The Myth That Schools Shortchange Girls: Social Science in the Service of Deception” [Kleinfeld (1998)], and
- (d) *The War Against Boys: How Misguided Feminism Is Harming Our Young Men* [Sommers (2001)].

#SSG #SSB AAUW. 2001. *Beyond the Gender Wars: A Conversation About Girls, Boys, and Education*, online at < <http://www.aauw.org/research/upload/BeyondGenderWar.pdf> > (1.2MB).

#SSG #SSB AAUW. 2008. “*Where the Girls Are: The Facts About Gender Equity in Education*,” online at < <http://www.aauw.org/research/WhereGirlsAre.cfm> >:

Executive Summary at < [http://www.aauw.org/research/upload/whereGirlsAre\\_execSummary.pdf](http://www.aauw.org/research/upload/whereGirlsAre_execSummary.pdf) > (2.4 MB)); full report at < <http://www.aauw.org/research/upload/whereGirlsAre.pdf> > (7.2 MB).

According to the Executive Summary:

[This report] presents a comprehensive look at girls’ educational achievement during the past 35 years, paying special attention to the relationship between girls’ and boys’ progress. Analyses of results from national standardized tests such as the National Assessment of Educational Progress (NAEP) and the SAT and ACT college entrance examinations, as well as other measures of educational achievement, provide an overall picture of trends in gender equity from elementary school to college and beyond. Differences among girls and among boys by race/ethnicity and family income level are evaluated. Together these analyses support three overarching facts about gender equity in schools today:

1. Girls’ successes don’t come at boys’ expense. . . . .
2. On average, girls’ and boys’ educational performance has improved. . . . .
3. Understanding disparities by race/ethnicity and family income level is critical to understanding girls’ and boys’ achievement.

#SSB Conlin, M. 2003. “The New Gender Gap: From kindergarten to grad school, boys are becoming the second sex,” *Business Week*, May 26; online at

< [http://www.businessweek.com/print/magazine/content/03\\_21/b3834001\\_mz001.htm?mz](http://www.businessweek.com/print/magazine/content/03_21/b3834001_mz001.htm?mz) >.

#SSB Kleinfeld, J. 1998. “The Myth That Schools Shortchange Girls: Social Science in the Service of Deception,” online at < <http://www.uaf.edu/northern/schools/myth.html> >; prepared for “The Women’s Freedom Network” < <http://www.womensfreedom.org/> >. According to < <http://www.judithkleinfeld.com/> >, Kleinfeld is the Director of Northern Studies Program and a Professor of Psychology at the University of Alaska Fairbanks.

**#SSG** Pipher, M. 2005. *Reviving Ophelia: Saving the selves of adolescent girls*. Riverhead Trade, Amazon..com information at <<http://tinyurl.com/5orxuq>> :

“At adolescence, says Mary Pipher, ‘girls become ‘female impersonators’ who fit their whole selves into small, crowded spaces.’ Many lose spark, interest, and even IQ points as a ‘girl-poisoning’ society forces a choice between being shunned for staying true to oneself and struggling to stay within a narrow definition of female. Pipher’s alarming tales of a generation swamped by pain may be partly informed by her role as a therapist who sees troubled children and teens, but her sketch of a tougher, more menacing world for girls often hits the mark. She offers some prescriptions for changing society and helping girls resist.”

**#SSG** Sadker, M, & D. Sadker. 1995. *Failing At Fairness: How Our Schools Cheat Girls*. Scribner. Amazon.com information at <<http://www.amazon.com/Failing-At-Fairness-Schools-Cheat/dp/068480073X>>. Note the “Search Inside” feature.

**#SSB** Smith, M.W. & J.D. Wilhelm. 2002. “*Reading Don't Fix No Chevy's: Literacy in the Lives of Young Men*. Heinemann, publisher’s information at <<http://books.heinemann.com/products/0509.aspx>> :

“Through a variety of creative research methods and an extended series of interviews with 49 young men in middle and high school who differ in class, race, academic achievement, kind of school, and geography, the authors identified the factors that motivated these young men to become accomplished in the activities they most enjoyed—factors that marked the boys' literate activities outside of school, but were largely absent from their literate lives in school. Their study questions the way reading and literature are typically taught and suggests powerful alternatives to traditional instruction.”

**#SSB** Sommers, C.H. 2001. *The War Against Boys: How Misguided Feminism Is Harming Our Young Men*, Simon & Schuster. Amazon.com information at <<http://tinyurl.com/6mx4kc>>. According to <[http://en.wikipedia.org/wiki/Christina\\_Hoff\\_Sommers](http://en.wikipedia.org/wiki/Christina_Hoff_Sommers)> :

Christina Hoff Sommers, Ph.D. (born 1950) is an American author who researches culture, adolescents, and morality in American society. . . . A former philosophy professor in Ethics at Clark University in Worcester, Massachusetts, she is a resident scholar at the American Enterprise Institute. . . . . [<<http://www.aei.org/>>]. . . for Public Policy Research, and a member of the Board of Advisors of the Foundation for Individual Rights in Education. . . [<<http://www.thefire.org/>>]. . . .

#SSG Spears, J.D. 2008. "Seeing Gender" *Phys. Teach.* **46**(3): 136-137, online to subscribers at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=PHTEAH&Volume=46&Issue=3>>. Spears wrote: Most educators see gender bias in schools as a thing of the past. Yet women's participation in science, technology, engineering, and mathematics (STEM) fields continues to lag behind men. Women have made more progress in law and medicine than in physics.

To be sure, the blatant barriers that I and other women experienced as undergraduate physics majors in the 1960s are gone—they are unthinkable in today's schools and universities. What remains is a layer of subtle barriers. ....

"Seeing Gender: Tools for Change" is an interactive CD-ROM that introduces the research on how males and females experience education differently. Developed with funding from the National Science Foundation (Grant # 0225184), the project grew out of work with middle and high school mathematics and science teachers as part of a graduate level course.

An opening module, "Gender Schemas," presents the larger framework from which to understand the more subtle biases that operate in STEM classrooms. Three modules, "Teachers," "Girls," and "Boys," explore how gender schema contributes to classroom interactions that discourage girls. The concluding module, "Undoing Accumulated Disadvantage," introduces a series of strategies for making STEM classrooms more equitable. A companion CD provides templates for professional development workshops ranging in duration from a couple of hours to a complete day as well as supplementary materials.

"Seeing Gender" is available at no cost through the Midwest Equity Assistance Center at Kansas State University. The material included in both CDs is available at <<http://www.meac.org>>. A link is provided at the bottom of the homepage. Individuals can download the files and burn their own CDs for either individual or group use.

#DM #SSG Trie, L. 2006. "Biases must be tackled to achieve gender equity in mathematics, scholars argue." *Stanford Report*, 15 February; online at <<http://news-service.stanford.edu/news/2006/february15/mathem-021506.html>>. Trie wrote: A year after Harvard President Lawrence Summers' remarks suggesting innate gender differences in science and math ability, the Institute for Research on Women and Gender (IRWG) on Feb. 7 hosted an event titled "Proof and Prejudice: Women in Mathematics," to examine the culture of mathematics in this country and women's experience as professional mathematicians. . . . . Despite advances, unexamined biases remain within the culture of mathematics and science, Schiebinger said. "Many are held unconsciously by men and also by women—in university math departments as well as in our society in general," she added. . . . *Margot Gerritsen, a Stanford assistant professor of petroleum engineering who teaches mathematics, said there are no differences in ability between her male and female students.* "There are big differences . . . in attitude and perception," she said. "I've seen much higher stress levels in women starting academic careers—about how they can contribute and fit in—than with the men." Male students are more likely to shrug off temporary setbacks, such as a poor test result, than women, she said. . . . Stanford Associate Professor of Education Jo Boaler . . . . [our insert – now at Sussex University in England as the Marie Curie professor in Education]. . . . , an expert in mathematics education who spoke as a member of the audience, said elementary school teachers should not be blamed. *Girls and boys achieve at similar levels in mathematics through school and at the undergraduate level, she said.* "Girls are still achieving at very high levels across the board—that's the message that should go out there," she said. "The idea that they're not is damaging in its own right." But after college, she said, the numbers drop off. According to Schiebinger, women earn 46 percent of undergraduate math degrees in this country but represent only 8 percent of math professors. . . . [our insert - Schiebinger may have meant "math full professors" – see Hale (2006)]. . . . Mathematics has a public relations problem in this country, particularly among some girls and women, according to Hollywood actress Danica McKellar. "Nobody out there is saying that smart is sexy and smart is important," said McKellar, the co-author of a mathematical proof. "Role models like Paris Hilton have everything to do with why this country is being dumbed down. We need better PR." . . . . *Even women who make it as mathematicians often feel excluded from the broader culture,* said Claudia Henrion. . . . [(1997)]. . . . , author of *Women in Mathematics: The Addition of Difference*. In researching the book, a recurring theme arose, she said: "The women were very accomplished but they still felt as outsiders in the math community." The talent exists, Henrion said, so the question must be, "How do we cultivate it and how do we create communities in which it is maximized?"

Trie's report is featured in Rick Reis's (2006) "Proof and Prejudice: Women in Mathematics," and in the discussion list post by Hake (2006a).

#SSB Weaver-Hightower, M. B. 2003. "The 'boy turn' in research on gender and education," *Review of Educational Research* 73(4): 471–498, online to subscribers at <<http://rer.sagepub.com/cgi/reprint/73/4/471>>.

#SSG #SSB Weaver-Hightower, M.B. 2008. "An Ecology Metaphor for Educational Policy Analysis: A Call for Complexity," *Educational Researcher* 37(3): 153-167; online at <[http://www.aera.net/publications/Default.aspx?menu\\_id=38&id=5238](http://www.aera.net/publications/Default.aspx?menu_id=38&id=5238)>. The abstract reads:

"Educational policy might productively be conceptualized with an ecology metaphor. Each policy, thus considered, exists within a complex system that reflects varied international, national, regional, and local dynamics. Using this metaphor provides policy analysts with a view of the regularities and irregularities of any policy, its process, its texts, its reception, and its degree of implementation. The characteristics of policy ecologies alert analysts to the possibilities of great transformation, for good or ill, and give them a way to conceptualize how such transformations occur. Perhaps most important, using an ecology metaphor suggests specific ways that progressive researchers might positively intervene in the policy process."

Weaver Hightower wrote (*italics* in the original):

"Scholarship on girls' education has continued, but the pressure for girls' issues peaked in the early 1990s, particularly after high-profile reports (American Association of University Women (1992) and popular trade books [e.g., Pipher (1994); Sadker & Sadker (1994)], eventually catalyzed federal policy for girls, particularly the 1994 Gender Equity in Education Act. The act brought considerable new *inputs* into the ecology, as government funding briefly flowed to girls' education. Key changes have occurred in the *extant conditions* of gender and education since the late 1990s, however, with a perceptible *boy turn* (Weaver-Hightower, 2003) occurring in gender and education policy and practice. One might view this turn as a *succession* in the policy ecology."

## **M. Sex Differences in Mathematical Ability: Fact or Artifact? #SDMA**

#SDMA AEI. 2007. American Enterprise Institute, Event of 1 October on Women and Science (Transcript, Audio, and Video) online at <<http://www.aei.org/events/eventID.1536,filter.all/transcript.asp>>. Speaker and panelist biographies are at <<http://www.aei.org/events/contentID.20070927141515154/default.asp>>.

### **Panel #1. The Science on Women and Science: What the Data Say**

*Moderator:* Christina Hoff Sommers, AEI

*Panelists:*

Rosalind Chaitt Barnett, Brandeis University;  
David Geary, University of Missouri;  
Richard Haier, University of California–Irvine Medical School;  
Elizabeth Spelke, Harvard University.

### **Panel #2. Stereotype Threat: The State of the Research**

*Moderator:* Christina Hoff Sommers, AEI

*Panelists:*

Joshua Aronson, New York University;  
Amy Wax, University of Pennsylvania Law School.

**Speaker: Charles Murray, AEI** [our insert - co-author of *The Bell Curve*,

<[http://www.aei.org/books/bookID.445/book\\_detail.asp](http://www.aei.org/books/bookID.445/book_detail.asp)>]

See also “Academic Inquisitors” [Sommers (2007)].

#SDMA APA. 2008. American Psychological Association, “Gender Issues,” online at

<<http://www.psychologymatters.org/gender.html>>:

a. “Men and Women: No Big Difference”; online at

<<http://www.psychologymatters.org/nodifference.html>>;

b. “Think Again: Men and Women Share Cognitive Skills: Research debunks myths about cognitive differences”; online at <<http://www.psychologymatters.org/thinkagain.html>>.

#SDMA AWM. 2005. Association for Women in Mathematics, AWM petition to President Bush and Secretary of Education Spellings: “Concern regarding the inclusion of Dr. Camilla Benbow on the National Mathematics Advisory Panel,” online at <[http://www.awm-math.org/benbow\\_petition/benbow\\_petition.html](http://www.awm-math.org/benbow_petition/benbow_petition.html)>. Despite the AWM’s petition, Benbow became the vice-chair of the committee – see “National Mathematics Advisory Panel Releases Final Report” [USDE (2008)] and references appended thereto.

See also the AWM petition’s background information at

<[http://www.awm-math.org/benbow\\_petition/background.html](http://www.awm-math.org/benbow_petition/background.html)> for a thorough critique of the Benbow & Stanley (1980) research and its sequels on the male-to-female ratios on the SAT (math) test for 12- and 13-year-old students scoring over 700. Among points in the critique are:

- (a) The ratio of 13 found by Benbow & Stanley (1983), declined to 4 in 1997 [Stanley (1997)], and to 2.8 in 2005 [Monastersky (2005)]. . . . [our insert – the ratio decline has also been pointed out by Linn (2007) and by Halpern et al. (2007a)].
- (b) The ratio decline “is consistent with changes in other measures: 48% of the undergraduate mathematics degrees in the U.S. now go to women, up from 40% in the 1970s [NSF (2004b)]; about one third of the PhDs in mathematics going to U.S. citizens go to women (this percentage has more than doubled since the 1970s) [AMS (2006, p. 236)]; women have even begun to make inroads into the rarified air of the prestigious Putman competition: for decades no woman placed in the top fifteen, but in 2004 there were four women in this exceptional group [Olson (2006)]”. . . . [our insert – this suggests that the ratio is strongly influenced by nurture]. . .
- (c) The ratio decline has been ignored in publications by Benbow (1988, pp. 172, 182), Lubensky & Benbow (1992), Benbow *et al.* (2000), Pinker (2003), and Geary (1989). . . . [our insert – and in Kimura (2007) and in Benbow’s (2008) profile]. . . . Pinker (2003) references Hedges and Nowell (1995) and Lubinski and Benbow (1992) – see “e” below. Geary is a member of the National Mathematics Advisory Panel [see USDE (2007) and references appended thereto].
- (d) “Benbow’s (1988) 14-page article in *Behavioral and Brain Sciences* is followed by 34 pages of commentary, mainly from psychologists, that includes critiques of methodology. [In addition,] Eccles and Jacobs (1986) discuss Benbow and Stanley’s assumptions about students’ formal mathematical experiences in light of empirical studies of SAT performance and course taking. Ruskai (1991) notes also that the Hopkins Center practice of sending students brochures stating that boys outperform girls on the mathematics SAT could bias results.”
- (e) According to Hemel’s (2005b) interview with Lawrence Summers, Summers’ speculation on innate gender differences in math/science abilities came from scholars cited in Pinker’s (2003) *The Blank Slate: The Modern Denial of Human Nature*. According to reference 20 in the AWM background report, among the scholars cited by Pinker are Lubinski and Benbow (1992) and Hedges and Nowell (1995).

See also “Perceptions and research: Mathematics, gender, and the SAT” [Kessel (2006c)].

#EB #SDMA Baron-Cohen, S. 2004. *The Essential Difference: Male And Female Brains And The Truth About Autism*. Basic Books. Amazon.com information at <<http://tinyurl.com/5fp5ll>>. Note the “Search Inside” feature.

“FROM PUBLISHERS WEEKLY: Should the title fail to express Baron-Cohen's certainty about gender differences, the Cambridge Univ. professor of psychology and psychiatry lays out his controversial thesis on page one: ‘The female brain is predominantly hard-wired for empathy. The male brain is predominantly hard-wired for understanding and building systems.’ Defending this bold view is a tough but engaging battle, one that's alleviated by Baron-Cohen's disclaimer that his conclusions refer to statistical majorities rather than ‘all men’ and ‘all women,’ but exacerbated by his habit of simultaneously skirting and employing gender stereotypes. His copious evidence ranges from the anecdotal to the anthropological, and from the neurological to the case study (the author and his research team conducted many of these studies).”

#SDMA Benbow, C.P. & J. Stanley. 1980. “Sex differences in mathematical ability: Fact or artifact?” *Science* 210: 1262-1264; online at <<http://www.vanderbilt.edu/Peabody/SMPY/ScienceFactOrArtifact.pdf>> (1.1MB):

Abstract: A substantial sex difference in mathematical reasoning ability (score on the mathematics test of the Scholastic Aptitude Test) in favor of boys was found in a study of 9927 intellectually gifted junior high school students. Our data contradict the hypothesis that differential course-taking accounts for observed sex differences in mathematical ability, but support the hypothesis that these differences are somewhat increased by environmental influences.

According to Benbow & Stanley (1983) there were responses to Benbow & Stanley (1980) by C. Tomizuka & S. Tobias; E. Stage & R. Karplus; S. Chipman; E. Egelman *et al.*; D. Moran; E. Luchins & A. Luchins; A. Kelly; and C. Benbow & J. Stanley; *Science* 212: 114-121 (1981).

In addition, a search at <<http://www.sciencemag.org/search.dtl>> for the keywords (anywhere in the article) “Benbow mathematical” (all of these words - without the quotes) for times posted between January 1980 and May 2008 yielded 42 hits. The responses of Stage & Karplus (1981) and Tomizuka & Tobias (1981) may be of special interest to physicists, but the Science search engine failed to turn up the latter. The more recent hits were Linn (2007), Mervis (2006), and Hedges & Newell (1995).

#SDMA Benbow, C.P., & J.C. Stanley. 1981. “Mathematical ability: Is sex a factor?” [A response]. *Science* 212: 118-121; online to subscribers at <<http://tinyurl.com/3e9zl7>>.

SDMA Benbow, C.P. & J. Stanley. 1983. “Sex Differences in Mathematical Reasoning Ability: More Facts,” *Science* 222: 1029-1031; online at

<<http://www.vanderbilt.edu/Peabody/SMPY/ScienceMoreFacts.pdf>> (1.1 MB) :

Abstract: Almost 40,000 selected seventh-grade students from the Middle Atlantic region of the United States took the College Board Scholastic Aptitude Test as part of the Johns Hopkins regional talent search in 1980, 1981, and 1982. A separate nationwide talent search was conducted in which any student under age 13 who was willing to take the test was eligible. The results obtained by both procedures establish that by age 13 a large sex difference in mathematical reasoning ability exists and that it is especially pronounced at the high end of the distribution: *among students who scored  $\geq 700$ , boys outnumbered girls 13 to 1*. Some hypothesized explanations of such differences were not supported by the data. [Our *italics*.]

**#SDMA** Benbow, C.P. 1988. "Sex Differences in mathematical reasoning ability in intellectually talented preadolescents: Their nature, effects, and possible causes," *Behavioral and Brain Sciences*, **11**:169-232; online at <<http://www.vanderbilt.edu/Peabody/SMPY/BBSBenbow.pdf>> (33 MB). Benbow's 15-page article, pp. 169-183, is followed by (a) 35 pages of "Open Peer Commentary," pp. 183-217; (b) 9 pages of Benbow's response, pp. 217-225; and (c) 8 pages of References, pp. 225-232. Benbow's abstract is:

"Several hundred thousand intellectually talented 12- to 13-year olds have been tested nationwide over the past 16 years with the mathematics and verbal sections of the Scholastic Aptitude test (SAT). Although no sex differences in verbal ability have been found, there have been consistent sex differences favoring males in mathematical reasoning ability, as measured by the mathematics section of the SAT (SAT-M). These differences are most pronounced at the highest levels of mathematical reasoning, they are stable over time . . . .[our insert – if "differences" means the male-to-female ratios on the SAT (math) test for 12- and 13-year-old students scoring over 700, then the ratios have been "stable" in the sense that they have always been greater than two, but the magnitude has diminished with time from 13 in 1983 to 2.8 in 2005 - see e.g. AMW (2005), Linn (2007), Halpern *et al.* (2007a,b)]. . . . , and they are observed in other countries as well. The sex difference in mathematical reasoning ability can predict subsequent sex differences in achievement in mathematics and science and is therefore of practical importance. To date a primarily environmental explanation for the difference in ability has not received support from the numerous studies conducted over the many years by the staff of the Study of Mathematically Precocious Youth (SMPY) and others. We have studied some of the classical environmental hypotheses: attitudes towards mathematics, perceived usefulness of mathematics, confidence, expectations/encouragement from parents and others, sex-typing, and differential course taking. In addition, several physiological correlates of extremely high mathematical reasoning ability have been identified (left-handedness, allergies, myopia, and perhaps bilateral representation of cognitive functions and prenatal hormonal exposure). It is therefore proposed that the sex difference in SAT-M scores among intellectually talented students, which may be related to greater male variability, results from both environmental and biological factors.

**#SDMA** Benbow, C. P., & D. Lubinski. 1993. "Psychological profiles of the mathematically talented: Some sex differences and evidence supporting their biological basis. In *The Origins and Development of High Ability. Ciba Foundation Symposium*, 178 (pp. 44-66). Oxford: John Wiley & Sons.

**#SDMA** Benbow, C.P., D. Lubinski, D. Shea, & H. Eftekhari-Sanjani. 2000. "Sex Differences in Mathematical Ability at Age 13: Their Status 20 Years Later," *Psychological Scientist* **11** (6): 474-487, p. 474; online at <<http://www.vanderbilt.edu/Peabody/SMPY/SexDiffs.pdf>> (844 kB): Abstract: "Reported is the 20-year follow up of 1,975 mathematically gifted adolescents (top 1%) whose assessments at age 12 to 14 revealed robust gender differences in mathematical reasoning ability . . . . [our insert – more precisely, "gender differences in scores on the mathematical aptitude portion of the SAT]. . . . Both sexes became exceptional achievers and perceived themselves as such; they reported uniformly high levels of degree attainment and satisfaction with both their career direction and overall success. The earlier sex differences in mathematical reasoning ability did predict differential educational and occupational outcomes. The observed differences also appeared to be a function of sex differences in preferences for (a) inorganic versus organic disciplines and (b) a career-focused versus more-balanced life. Because profile differences in abilities and preferences are longitudinally stable, males probably will remain more represented in some disciplines, whereas females are likely to remain more represented in others. These data have policy implications for higher education and the world of work."

**#SDMA** Benbow, C. P., & D. Lubinski. 2008. "Study of Mathematically Precocious Youth (SMPY)," online at <<http://www.vanderbilt.edu/Peabody/SMPY/>> :

"The Study of Mathematically Precocious Youth (SMPY) was founded by Julian C. Stanley, on 1 September 1971, at Johns Hopkins University. Camilla P. Benbow and David Lubinski co-direct SMPY at Peabody College of Vanderbilt University. They are planning to complete a 50-year longitudinal study of five cohorts, consisting of over 5,000 intellectually talented individuals, identified over a 25-year period (1972-1997). The aim of this research is to develop a better understanding of the unique needs of intellectually precocious youth and the determinants of the contrasting developmental trajectories they display over the lifespan. The Study of Mathematically Precocious Youth is a bit of a misnomer, however, because verbally precocious youth have been included for longitudinal tracking, and participants are now all adults. Nevertheless, 'SMPY' has been chosen to be retained to maintain consistency."

**#SDMA** Benbow, C.P. 2008. Profile at <<http://www.indiana.edu/~intell/benbow.shtml>>. Benbow wrote:

"The results Dr. Benbow and co-author Julian Stanley reported in 1980 suggested that gender differences in mathematical reasoning ability may have a biological origin, and that the intellectual disparity between males and females in math is only exacerbated by environmental influences, such as differential course-taking and socialization (Benbow & Stanley, 1980). The data, obtained from nearly 10,000 gifted middle school students participating in the longitudinal Study of Mathematically Precocious Youth (SMPY) demonstrated that the large gender differences in mathematical reasoning ability are robust, stable and emerge early in life . . . [our insert – if "differences" means the measured male-to-female ratios on the SAT (math) test for 12- and 13-year-old students scoring over 700, then the ratios have been "stable" in the sense that they have always been greater than two, but the magnitude has diminished with time from 13 in 1983 to 2.8 in 2005 - see e.g. AWM (2005), Linn (2007), Halpern *et al.* (2007a,b)]. . . . In the years since the original study, data from the SMPY have continued [to] support this hypothesis (Raymond & Benbow, 1986; Benbow & Lubinski, 1993)."

**#SDMA** Brody, L.E., L.B. Barnett, & C.J. Mills. 1994. "Gender Differences Among Talented Adolescents: Research Studies by SMPY and CTY at Johns Hopkins," in *Competence and Responsibility: The Third European Conference of the European Council for High Ability*, ed. by K. A. Heller and E. A. Hany. Hogrefe & Huber publishers.

**#SDMA** Ceci, S.J. & W.M. Williams, eds. 2006. *Why Aren't More Women in Science?: Top Researchers Debate the Evidence*. American Psychological Association (APA), publisher's information, including the Table of Contents, is at <<http://books.apa.org/books.cfm?id=4316085>>. For an interview with Wendy Williams regarding this book see Phillips (2008). The APA wrote:

"Why aren't more women pursuing careers in science, engineering, and math? Is the lack of women in these fields a consequence of societal discouragements, innate differences in ability between the sexes, or differences in aspirations? These questions always spark a host of other questions—and a multiplicity of answers—all of which have important implications for gender equality and for retaining the nation's competitiveness in the technological marketplace.

The most reliable and current knowledge about women's participation in science is presented in this collection of fifteen essays written by top researchers on gender differences in ability. The essayists were chosen to reflect the diversity and complexity of views on the topic, about which knowledge has been accumulating and evolving for decades. The editors provide an introduction that defines the key issues and embeds them in historical context and a conclusion that synthesizes and integrates the disparate views. Written accessibly to appeal to students and non-specialists as well as psychologists and other social scientists, the contributors reframe this key controversy and challenge readers' emotional and political biases through solid empirical science."

For reviews see "Women in STEM Careers" [Reilly (2007b)] and "Women In Science: Can Evidence Inform the Debate?" [Linn (2007)]. See also "Women in Academe, and the Men Who Derail Them" [Williams (2002)].

**#SDMA** Davies, A.P.C. & T.K. Shackelford. 2006. "An Evolutionary Psychological Perspective on Gender Similarities and Differences," *American Psychologist* **61**(6): 640-641, response to Hyde (2005); online as a 40 kB pdf at <<http://tinyurl.com/6or89u>>. At the same URL is the response "Judgments of Similarity Are Psychological: The Importance of Importance" by G. E. Zuriff and Hyde's "Gender Similarities Still Rule," a reply to the responses.

**#SDMA** Eccles, J.S & J.E Jacobs. 1986. "Social Forces Shape Math Attitudes and Performance," *Signs: Journal of Women in Culture and Society* **11**(2): 367-380; online to subscribers at <<http://www.jstor.org/pss/3174058>>. References that cite this article are given at <<http://www.journals.uchicago.edu/doi/abs/10.1086/494229>>.

**#SDMA** Friedman, L. 1989. "Mathematics and the gender gap: A meta-analysis of recent studies of sex differences in mathematical tasks," *Review of Educational Research* **59**(2): 185-213; online at <<http://rer.sagepub.com/cgi/reprint/59/2/185>>:

"This paper is a meta-analysis of studies that have taken place between 1974 and mid-1987 on sex differences in mathematical tasks. The methods used are estimations of (a) parameters for a random effects model and (b) coefficients for a linear regression equation, all based on effect sizes calculated from each study. These results are compared with meta-analyses of the studies on quantitative skill collected by Maccoby and Jacklin. These comparisons, together with ad hoc comparisons of Scholastic Aptitude Test effect sizes over the years, yield two conclusions. First, the average sex difference is very small; a confidence interval for it covers zero, though the interval lies mainly on the side of male advantage. Second, sex differences in performance are decreasing over the years."

#SDMA Gallagher, A.M. & J.C. Kaufman, eds. 2005. *Gender Differences in Mathematics: An Integrative Psychological Approach*. Cambridge University Press (CUP), publisher's information at

<<http://assets.cambridge.org/97805218/26051/sample/9780521826051ws.pdf>> (148 kB):

“Females consistently score lower than males on standardized tests of mathematics – yet no such differences exist in the classroom. These differences are not trivial, nor are they insignificant. Test scores help determine entrance to college and graduate school and therefore, by extension, a person’s job and future success. If females receive lower test scores then they also receive fewer opportunities. Why does this discrepancy exist? This book presents a series of papers that address these issues by integrating the latest research findings and theories. Authors such as Diane Halpern, Jacquelynne Eccles, Beth Casey, Ronald Nuttal, James Byrnes, and Frank Pajares tackle these questions from a variety of perspectives. Many different branches of psychology are represented, including cognitive, social, personality/self-oriented, and psychobiological. The editors then present an integrative chapter that discusses the ideas presented and other areas that the field should explore.”

Reviewed by Linn & Kessel (2006).

A Google ‘book preview’ is online at <<http://tinyurl.com/5cy7hz>>.

#IC #SDMA Guiso, L., F. Monte, P. Sapienza, & L. Zingales. 2008. “Diversity: Culture, Gender, and Math - Analysis of PISA results suggests that the gender gap in math scores disappears in countries with a more gender-equal culture,” *Science* 320(5880): 1164 - 1165, 30 May; online to subscribers at <<http://tinyurl.com/5wwehg>>. An abstract is online at <<http://www.sciencemag.org/cgi/content/summary/320/5880/1164>>. The entire article is free online on the Math-Teach archives

<<http://mathforum.org/kb/thread.jspa?threadID=1757413&tstart=0>>, thanks to Jerry Becker.

[Becker’s use of copyrighted material is in accord the “fair use” provision of the section 107 of the US Copyright Law – see e.g., <<http://www.law.cornell.edu/uscode/17/107.shtml>>.]

#SDMA Halpern, D. 2000. *Sex Differences in Cognitive Ability*. Lawrence Erlbaum; 3<sup>rd</sup> edition. Amazon.com information at <<http://tinyurl.com/6s4shd>>. Note the “Look Inside” feature. In the introduction Halpern writes: “The focus of the sex difference questions needs to change from ‘Who is better?’ to ‘Where and when are meaningful differences found?’ ” For another excerpt from Halpern’s introduction see the reference to Pinker & Spelke (2005).

A Google “book preview” is online at <<http://tinyurl.com/6s4wr7>>. A search for “Benbow” discloses the following excerpt on page 115:

“Johns Hopkins University has been involved in a nationwide talent search to identify boys and girls who are exceptionally talented in mathematics [Benbow (1988), Benbow & Stanley (1980, 1981, 1983)]. One of the findings is that there are substantial sex differences in the number of girls and boys identified as ‘mathematically precocious.’ They reported that among seventh and eighth grade students identified as mathematically talented, the male-to-female ratios on the College Board’s SAT-M were as follows: 2:1 at greater than 500, 5:1 at greater than 600, and 17:1 at greater than 700 [Stanley & Benbow (1982)]. Furthermore Benbow (1988) reported that this ratio has remained stable for more than 15 years. . . . [our insert - the ratios have been “stable” in the sense that they have always been greater than two, but the magnitude has diminished with time from 13 in 1983 to 2.8 in 2005 - see e.g. AMW (2005), Linn (2007), Halpern *et al.* (2007a,b)]. . . . This is a considerable sex difference that has generated heated controversy and has received extensive coverage in the popular press and nonprint media. The fact that these differences emerged from very large samples and have been replicated many times lends credibility to those results. Do these differences reflect actual ability differences, or are they artifacts of the way the students were selected? Benbow and Stanley (1981) believe that students were selected in an unbiased manner and that the large sex differences are attributable, at least in part, to biological mechanisms, whereas the detractors argue that girls will always be underrepresented in fields that are defined by society as masculine [e.g., Halpern (1988)]. These two possibilities are considered in the following chapters in this book.”

[See Halpern (2000) for the above references: Stanley & Benbow (1982) and Halpern (1988).]

Diane Halpern <<http://www.claremontmckenna.edu/academic/faculty/profile.asp?Fac=302>> is chair of the Department of Psychology, Claremont McKenna College, and past president of the American Psychological Association.

#SDMA Halpern, D.F., C.P. Benbow, D.C. Geary, R. Gur, J.S. Hyde, & M.A. Gernsbacher. 2007a. "The science of sex differences in science and mathematics," *Psychological Science in the Public Interest* 8: 1-51; contains a large set of references; online at <<http://www.vanderbilt.edu/Peabody/SMPY/ScienceSexDifferences.pdf>> (880 kB). Their summary concludes:

"A wide range of sociocultural forces contribute to sex differences in mathematics and science achievement and ability—including the effects of family, neighborhood, peer, and school influences; training and experience; and cultural practices. We conclude that early experience, biological factors, educational policy, and cultural context affect the number of women and men who pursue advanced study in science and math and that these effects add and interact in complex ways. There are no single or simple answers to the complex questions about sex differences in science and mathematics."

Halpern *et al.* also wrote:

"Stanley, who studied mathematically precocious youth for decades, explained that 25 years ago there were 13 boys for every girl who scored above 700 on the SAT-M at age 13. Now the ratio is only 2.8:1, which is a precipitous drop that has not been widely reported in the news media. According to Stanley, 'It's gone way down as women have had the opportunity to take their math earlier' (quoted in Monastersky (2005)). There are no studies exploring the reasons for the decline, although possible reasons include that fact that high-school mathematics coursework for boys and girls has become more similar and more girls are getting more encouragement in the form of special programs and mentoring to encourage their participation in higher-level math courses. Regardless, these results suggest that the male advantage for mathematical skills may be limited to the upper end of the ability distribution."

#SDMA Halpern, D.F., C.P. Benbow, D.C. Geary, R. Gur, J.S. Hyde, & M.A. Gernsbacher. 2007b. "Sex, Math and Scientific Achievement: Why do men dominate the fields of science, engineering and mathematics?" *Scientific American*, November; online at <<http://www.sciam.com/article.cfm?id=sex-math-and-scientific-achievement>>. The key concept are listed as :

"Women, on average, have stronger verbal skills (especially in writing) and better memory for events, words, objects, faces and activities.

Men generally are better at mentally manipulating objects and at performing certain quantitative tasks that rely on visual representations.

*Intervention studies are still in their infancy but suggest both sexes can benefit from targeted training to improve their skill set.*" [Our italics.]

Regarding Benbow & Stanley (1980) and its sequels, Halpern *et al.* wrote:

"Although it has drawn little media coverage, dramatic changes have been occurring among these junior math wizards: the relative number of girls among them has been soaring. The ratio of boys to girls, first observed at 13 to 1 in the 1980s, has been dropping steadily and is now only about 3 to 1. During the same period the number of women in a few other scientific fields has surged. In the U.S., women now make up half of new medical school graduates and 75 percent of recent veterinary school graduates. We cannot identify any single cause for the increase in the number of women entering these formerly male-dominated fields, because multiple changes have occurred in society over the past several decades."

#SDMA Hedges, L.V. and A. Nowell. 1995. "Sex differences in mental test scores, variability, and numbers of high-scoring individuals," *Science* 269(5220): 41-45; abstract online at <<http://www.sciencemag.org/cgi/content/abstract/269/5220/41>>. Hedges & Nowell wrote:

"Sex differences in central tendency, variability, and numbers of high scores on mental tests have been extensively studied. Research has not always seemed to yield consistent results, partly because most studies have not used representative samples of national populations. An analysis of mental test scores from six studies that used national probability samples provided evidence that although average sex differences have been generally small and stable over time, the test scores of males consistently have larger variance. Except in tests of reading comprehension, perceptual speed, and associative memory, males typically outnumber females substantially among high-scoring individuals."

#SSGD #SDMA Hemel, D.J. 2005b. "Sociologist Cited By Summers Calls His Talk 'Uninformed'" *Harvard Crimson*, 19 January, online at

<<http://www.thecrimson.com/article.aspx?ref=505363>>. Hemel wrote:

Two sociologists whose research University President Lawrence H. Summers cited at an economics conference Friday said yesterday their findings do not support Summers' suggestion that "innate differences" may account for the under-representation of women in the sciences.

University of California-Davis sociologist Kimberlee A. Shauman said that Summers' remarks were "uninformed." The other researcher, University of Michigan sociologist Yu Xie, said he accepted Summers' comments as "scholarly propositions," although he said his own analysis "goes against Larry's suggestion that math ability is something innate."

Xie and Shauman presented their findings at the National Bureau of Economic Research Friday afternoon, shortly after Summers' remarks.

In an interview with The Crimson last night, Summers stressed that he only cited Xie and Shauman's research. . . . [our insert - see Xie & Shauman (2005)]. . . . as evidence that females are underrepresented among the top 5 percent of test-takers on standardized assessments. *Summers said the evidence for his speculative hypothesis that biological differences may partially account for this gender gap comes instead from scholars cited in Johnstone Family Professor of Psychology Steven Pinker's bestselling 2003 book The Blank Slate: The Modern Denial of Human Nature. . . . [Our italics.]* [Our insert – according to reference 20 of the background information for the AWM's (2005) petition "Concern regarding the inclusion of Dr. Camilla Benbow on the National Mathematics Advisory Panel," among the scholars cited by Pinker are Hedges and Nowell (1995) and Lubinski and Benbow (1992).]

#SDMA Hyde, J.S., E. Fennema, & S. Lamon. 1990. "Gender differences in mathematics performance: A meta-analysis, *Psychological Bulletin* 107: 139-155; online at <[http://www.plantpath.wisc.edu/CZA%20WS%20530/Hyde\\_et\\_al.'90.pdf](http://www.plantpath.wisc.edu/CZA%20WS%20530/Hyde_et_al.'90.pdf)>. The abstract concludes:

"The magnitude of the gender difference has declined over the years; for studies published in 1973 or earlier d was 0.31, whereas it was 0.14 for studies published in 1974 or later. . . . [our insert – evidently "d" is the "Cohen (1986) effect size"]. . . . We conclude that gender differences in mathematics performance are small. Nonetheless, the lower performance of women in problem solving that is evident in high school requires attention."

#SDMA Hyde, J. S. 2005. "The Gender Similarities Hypothesis," *American Psychologist* **60**(6): 581-592; online at <<http://www.apa.org/journals/releases/amp606581.pdf>>. For responses and a reply by Hyde see Davies & Shackelford (2006). The abstract of Hyde (2005) reads:

"The differences model, which argues that males and female are vastly different psychologically, dominates the popular media. Here, the author advances a very different view, the gender similarities hypothesis, which holds that males and females are similar on most, but not all, psychological variables. Results from a review of 46 meta-analyses support the gender similarities hypothesis. Gender differences can vary substantially in magnitude at different ages and depend on the context in which measurement occurs. Over inflated claims of gender differences carry substantial costs in areas such as the workplace and relationships."

#SDMA Hyde, J.S. and M.C. Linn. 2006. "Gender Similarities in Mathematics and Science,"

*Science* **314** (5799): 599-600, 27 October 2006; summary online at

<<http://www.sciencemag.org/cgi/content/summary/314/5799/599>> :

"Boys and girls have similar psychological traits and cognitive abilities; thus, a focus on factors other than gender is needed to help girls persist in mathematical and scientific career tracks."

A response by Melvin Konner <<http://www.anthropology.emory.edu/FACULTY/ANTMK/>>

Professor of Anthropology and Associate Professor of Psychiatry and Neurology at Emory University, is at <<http://www.sciencemag.org/cgi/eletters/314/5799/599#10140>>. Konner wrote:

"The article . . . [Hyde & Linn (2006)] . . . makes one very important point but obscures another. The sex difference in mathematical ability is small or trivial when we consider means and effect sizes. When assessing applicants for a position requiring average, high, or perhaps even very high mathematical ability, we should expect equal or almost equal numbers of males and females. However, the article neglects the tails of the distribution. . . . *The reality in mathematical ability, for example, is that male variance is higher, so that both tails extend beyond the female distribution.* . . . [Our italics - Konner echoes the standpoint of Benbow and colleagues]. . . . This fact lends a different interpretation of the similarities between the means and, more importantly, it suggests a predominance of males at the very top as well as at the bottom; both have been shown in many studies. For readers of *Science*, the very top is very important. Even for the Fields Medal, only the work, not the person, should matter, but the expectation of gender balance at this level is unfair and counterproductive. . . . to obscure the very different situation at the tails of the distribution is not going to help us move forward."

#SDMA Kessel, C. 2006a. "The trouble with SMPY." *AWM Newsletter* **36**(5): 27-30. [SMPY = Study of Mathematically Precocious Youth <<http://www.vanderbilt.edu/Peabody/SMPY/>>; see Benbow & Lubinski (2008)].

#SDMA Kessel, C. 2006c. "Perceptions and research: Mathematics, gender, and the SAT," *Focus* 26(9): 14-15; online at <<http://www.maa.org/pubs/december06focus.pdf>> (2.4 MB). Kessel wrote:

Camilla Benbow is the vice-chair of the National Mathematics Advisory Panel and has been recently appointed to the National Science Board, which oversees the National Science Foundation. Since 1980, the work of Benbow and her colleagues has received attention in the media ("Do males have a math gene?," *Newsweek*, 1980; "Academy of P.C. Sciences," *New York Times*, 2006) and in popular books (*Brain Sex: The Real Difference Between Men and Women*, 1991; *Boys and Girls Learn Differently!*, 2001), and recently on various web sites. This research is often perceived to support the view that humans have two extremely different patterns of cognition and behavior, and that these are explained by male and female brain differences.

At the same time, criticisms and findings that conflict with work of Benbow and her colleagues have received little notice, in the media and even in academic writing. In this article, I describe some of those criticisms and findings, and their relevance for current studies.

In 1980, Camilla Benbow and Julian Stanley published an article in *Science* entitled "Sex Differences in Mathematical Ability: Fact or Artifact?" They reported large genderdifferences in "mathematical reasoning ability." Their evidence was scores on the mathematics SAT taken by seventh and eighth graders as part of a talent search for a program at Johns Hopkins University. ....

In 1983, Benbow and Stanley published another article in *Science* entitled "Sex Differences in Mathematical Reasoning Ability: More Facts" They reported that in talent searches in 1980, 1981, and 1982, about 13 boys to every 1 girl scored above 700. The numbers were very small (see table). In 1986, Camilla Benbow and Robert Benbow wrote that, based on talent search results, "it is quite clear that there are very large sex differences in mathematical reasoning ability" and that extensive studies conducted over a 14-year period had failed to show an "exclusively environmental explanation."

Between 1988 and 2000, the 13-to-1 ratio was reported in journal articles by Benbow and her colleagues (*Behavioral and Brain Science*, 1988; *Current Directions in Psychological Science*, 1992; *Psychological Scientist*, 2000). In 2000, Lubinski, Benbow, and Morelock gave the 13 to 1 ratio in the *International Handbook of Giftedness and Talent* and said, "Comparable ratios have been replicated across the U.S. in a number of talent searches (Benbow & Stanley, 1996), as well as in other cultures [no reference given]." However, in 1997, Stanley reported that the ratio had fallen to 4 to 1. [Our italics.] Earlier studies, published in 1994, of talent searches at Johns Hopkins and Duke University had also reported different, smaller ratios obtained from larger samples (see table). In 2005, Hopkins researchers reported this ratio as 3 to 1.

*Beyond Bias and Barriers*, a new report from the National Academies, notes the change from 13-to-1 to 3-to-1 and says, "This difference can obviously not be explained by biological factors and suggests that social and cultural changes in the education of men and women have influenced test scores." This echoes Schafer and Gray's earlier criticism that environmental and cultural factors could not be set aside. *Whatever the reason for the change in ratios, it seems unscientific to reiterate the 13-to-1 ratio, without explanation, when other studies consistently report conflicting findings.* [Our italics.]

**#EB #SDMA** Kimura, D. 2000. *Sex and Cognition*. MIT Press, publisher's information at <<http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=4364>>. Amazon.com information at <<http://tinyurl.com/6pd2nb>>. Note the "Look Inside" feature. The following quote is at the MIT press site:

"Kimura provides an authoritative overview of the field of sex differences in cognition, moving from hormones to cognition, genes to behavior, in a calm and clear way. This book will be a valuable resource for students and teachers of cognitive science."-- Simon Baron-Cohen, Departments of Experimental Psychology and Psychiatry, University of Cambridge, UK.

Doreen Kimura <<http://www.sfu.ca/~dkimura/dkhome.htm>> writes: "I have a post-retirement visiting professorship at Simon Fraser University in Burnaby, British Columbia. Prior to that I spent over 30 years at the University of Western Ontario in London, Canada."

**#SDMA** Kimura, D. 2002. "Sex Differences in the Brain," *Scientific American*, 13 May 13, abstract online at <<http://tinyurl.com/548ube>>. Kimura wrote:

"Men and women differ not only in their physical attributes and reproductive function but also in many other characteristics, including the way they solve intellectual problems. For the past few decades, it has been ideologically fashionable to insist that these behavioral differences are minimal and are the consequence of variations in experience during development before and after adolescence. *Evidence accumulated more recently, however, suggests that the effects of sex hormones on brain organization occur so early in life that from the start the environment is acting on differently wired brains in boys and girls.* [Our italics.] Such effects make evaluating the role of experience, independent of physiological predisposition, a difficult if not dubious task. The biological bases of sex differences in brain and behavior have become much better known through increasing numbers of behavioral, neurological and endocrinological studies."

**#SSIGD #SDMA** Kimura, D. 2004. "Hysteria trumps academic freedom," *Vancouver Sun*, p. A13, 1 February; online at <<http://www.sfu.ca/~dkimura/articles/hysteria.htm>>. Kimura wrote:

The recent suggestion by Larry Summers, Harvard University president, that one of the factors contributing to the lower representation of women in the sciences might be innate differences between the sexes has unleashed the predictable fury from feminists and their fellow ideologues. The responses to Summers indicate once again how little respect many in academia really have for the principles of academic freedom and rational discussion. Even had he been mistaken, the reaction should have been more moderate, but as it happens he was not.

Men and women do differ in their intellectual talents, and if by "innate" we mean influenced or determined before birth, then some of these differences are indeed innate. Differentiation between the sexes depends heavily on the difference between them in levels of sex hormones early in prenatal life. These hormone levels determine not only the physical differences, but also strongly influence many behaviours into adulthood. Those behaviours include the intellectual or cognitive pattern, hormonal influences being especially well documented for certain kinds of spatial ability, like being able to mentally rotate or manipulate visual objects.

Men are, on average, better on such spatial tasks and on mathematical reasoning tasks than are women. Women, in contrast are better, on average, on tasks requiring verbal memory (recalling word material), and also in recalling the position of objects presented in an array. There are many other less striking differences.

Mathematical reasoning ability is especially important for physical sciences like physics and engineering, and since many more men than women score at the high end of math aptitude tests, it is reasonable to expect that more men will go into those professions. Note that boys and girls may not differ in their grades on math tests in school, but the same boys still excel on math aptitude tests, where the items are less rehearsed. . . . .

Lest some people think that women still suffer discrimination in hiring in academia, the research, in Canada at least, shows just the opposite. Several studies have shown that women are favoured over men in university faculty hiring, including my own survey of hiring at two major British Columbia universities. Women's groups have been sadly effective at crying victim, to the point where men have become disadvantaged.

Dr. Summers has now disappointed all serious academics by his subsequent apology and retraction, bowing to pressures originating, not from thoughtful critiques of his remarks, but from hysterical reactions of special interest groups. His response is mirrored in too many university and research grant administrations, where the tired refrain is that women still suffer "serious obstacles", at best only vaguely defined, to success in science.

#SDMA Kimura, D. 2007. "Under-representation" or Misrepresentation?" in Ceci & Williams (2007); online at <<http://www.sfu.ca/~dkimura/articles/Ceci%20Essay.htm>>. Kimura wrote: "The Scholastic Aptitude Test- Mathematics (SAT-Math) has consistently over several decades yielded an advantage in High School age males. The participants selected for Benbow's (1988) studies of mathematically precocious youth (SMPY) have consistently shown a greater number of males. Even within this select group of boys and girls the average scores of boys are higher. The ratio of boys to girls at the high end of the distribution of scores is about ten to one. . . . [our insert - according to Monastersky (2005), the ratio in 2005 was 2.8 to 1]. . . . In the Putnam competition, open to all undergraduates in North America, what data we have suggests a huge preponderance of males who get the higher scores, even correcting for the larger numbers of male applicants. To date, all the recipients of the Fields medal, a prestigious award in mathematics, have been men."

#SDMA Levin, M. 1990. "Women – why so few," *Am. J. Phys.* **58**(10): 905-906; online at <<http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=58&Issue=10>>. A response to "Why so few women?" [Button-Shafer (1990)]. For a response to Levin see "[Guest Comment: Are there innate cognitive gender differences? Some comments on the evidence in response to a letter from M. Levin](#)" [Ruskai (1991)].

Levin cites the research of Benbow & Stanley (1981, 1983) purporting to show that are intrinsic gender differences in favor of males at the highest level of mathematical performance. This and other work of Benbow has been criticized in "Concern regarding the inclusion of Dr. Camilla Benbow on the National Mathematics Advisory Panel" [AWM (2005)]. According to <[http://en.wikipedia.org/wiki/Michael\\_Levin](http://en.wikipedia.org/wiki/Michael_Levin)>:

Professor Levin is known for his controversial views in philosophy. He is critical of certain strands of feminism. . . . Levin also believes that genetics play an important part in the variation in cultures across the world. He advocates reliabilism as the correct theory of epistemology, and compatibilism as the correct theory of free will. Professor Levin has written for libertarian publications such as the Ludwig von Mises Institute's newsletter *The Free Market* and *The Journal of Libertarian Studies*. He has garnered attention for defending torture for political purposes as far back as 1982, in an opinion article featured in *Newsweek* magazine.

#SDMA Linn, M. 2007. "Women In Science: Can Evidence Inform the Debate?" *Science* 317(5835): 199 - 200, 13 July, review of Ceci & Williams (2006); online at <<http://tinyurl.com/4fltw3>>. Linn wrote:

"The chapter by David Lubinski and Camilla Benbow is one of several that mentions the 1980s talent search by Benbow and Julian Stanley, in which they recruited students under 14 to take the SAT and found that for scores over 700 (two standard deviations above the mean), the ratio was 13 boys to 1 girl. By 1997, the ratio had dropped to about 4 to 1 [Stanley (1997)]; it has recently fallen further to 2.8 to 1 [Monastersky (2005)]. [Our italicised references.] These large differences motivate some contributors to criticize others for ignoring the evidence for males' superior abilities in science. In the most dramatic statement, Doreen Kimura argues that giving special scholarships or grants exclusively to women "bribes them to enter fields they may neither excel in nor enjoy."

SDMA Linn, M.C. & C. Kessel. 2003. "Gender differences in cognition and educational performance," in Lynn Nadel, ed. *Encyclopedia of cognitive science* (pp. 261–267). Nature Publishing Group. Amazon.com information at <<http://tinyurl.com/4mnqpo>>.

#SDMA Linn, M.C. & C. Kessel. 2006. Review of *Gender Differences in Mathematics* [Gallagher & Kaufman (2005)]. *AWM Newsletter* 36(5): 20-27.

#SDMA ‡ Linn, M. & C. Kessel. 2007. "Gender Differences in Mathematics," *Psychology of Women Quarterly* 31: 323–324; online to subscribers at <<http://www.blackwellpublishing.com/journal.asp?ref=0361-6843&site=1>>. This is a shortened and altered version of Linn & Kessel (2006).

#SDMA Lubinski, D.S. & C. Benbow. 1992. "Gender Differences in Abilities and Preferences Among the Gifted: Implications for the Math-Science Pipeline," *Current Directions in Psychological Science* 1: 61-66; online at <<http://www.vanderbilt.edu/Peabody/SMPY/CurrentDirections.pdf>> (2.3 MB)

#SDMA Lubinski, D.S. & C. Benbow. 2006a. "Sex Differences in Personal Attributes for the Development of Scientific Expertise," in Ceci & Williams (2006).

#SDMA Lubinski, D.S. & C. Benbow. 2006b. "Study of Mathematically Precocious Youth After 35 Years: Uncovering Antecedents for the Development of Math-Science Expertise," *Perspectives On Psychological Science* 1(4): 316-345; online at <<http://www.vanderbilt.edu/Peabody/SMPY/DoingPsychScience2006.pdf>> (616 kB).

Abstract: This review provides an account of the Study of Mathematically Precocious Youth (SMPY) after 35 years of longitudinal research. Findings from recent 20-year follow-ups from three cohorts, plus 5- or 10-year findings from all five SMPY cohorts (totaling more than 5,000 participants), are presented. SMPY has devoted particular attention to uncovering personal antecedents necessary for the development of exceptional math-science careers and to developing educational interventions to facilitate learning among intellectually precocious youth. Along with mathematical gifts, high levels of spatial ability, investigative interests, and theoretical values form a particularly promising aptitude complex indicative of potential for developing scientific expertise and of sustained commitment to scientific pursuits. . . . . . in the SMPY cohorts, although more mathematically precocious males than females entered math-science careers, this does not necessarily imply a loss of talent because the women secured similar proportions of advanced degrees and high-level careers in areas more correspondent with the multidimensionality of their ability-preference pattern (e.g., administration, law, medicine, and the social sciences). By their mid-30s, the men and women appeared to be happy with their life choices and viewed themselves as equally successful (and objective measures support these subjective impressions). Given the ever-increasing importance of quantitative and scientific reasoning skills in modern cultures, *when mathematically gifted individuals choose to pursue careers outside engineering and the physical sciences, it should be seen as a contribution to society, not a loss of talent.* [Our italics.]

#SDMA Monastersky, R. 2005. Women and Science: The Debate Goes On: Primed for Numbers – Are boys better at math? Experts try to divide the influences of nature and nurture." *Chronicle of Higher Education* 51(26): A1, 4 March; online at

<<http://chronicle.com/free/v51/i26/26a00102.htm>>. Monastersky writes:

"Data from [Julian Stanley's] program, at Johns Hopkins, shows just how strong the cultural factors are in determining math achievement. In the early 1980s, he and [Camilla Benbow] reported. . . [Benbow & Stanley (1980)]. . . . a whopping disparity in the numbers of mathematically gifted boys and girls who scored 700 on the math section of the SAT at the age of 13, a distinction achieved by one in 10,000 students. *A quarter-century ago, there were 13 boys for every girl at that level. Now the ratio is only 2.8 to 1, a precipitous drop that has not been reported in the news media.* [Our italics.] 'It's gone way down as women have had an opportunity to take their math earlier,' says Mr. Stanley."

#EB #SDMA Pinker, S. 2003. *Blank Slate: The Modern Denial of Human Nature*. Penguin Group.

Barnes & Noble information at

<<http://search.barnesandnoble.com/Blank-Slate/Steven-Pinker/e/9780142003343/?itm=2>>.

Note the “See Inside” feature.

From *Publishers Weekly*:

.....Drawing on decades of research in the “sciences of human nature,” Pinker, a chaired professor of psychology at MIT, attacks the notion that an infant’s mind is a blank slate, arguing instead that human beings have an inherited universal structure shaped by the demands made upon the species for survival, albeit with plenty of room for cultural and individual variation. .... He goes on to tour what science currently claims to know about human nature, including its cognitive, intuitive and emotional faculties, and *shows what light this research can shed on such thorny topics as gender inequality, child-rearing and modern art.* [Our *italics*.]

Pinker’s advertisement at <<http://pinker.wjh.harvard.edu/books/tbs/index.html>> states:

“In *The Blank Slate*, Steven Pinker, bestselling author of *The Language Instinct* and *How the Mind Works*, explores the idea of human nature and its moral, emotional, and political colorings. He shows how many intellectuals have denied the existence of human nature by embracing three linked dogmas: The Blank Slate (the mind has no innate traits), The Noble Savage (people are born good and corrupted by society), and The Ghost in the Machine (each of us has a soul that makes choices free from biology). Each dogma carries a moral burden, so their defenders have engaged in the desperate tactics to discredit the scientists who are now challenging them.

Pinker tries to inject calm and rationality into these debates by showing that equality, progress, responsibility, and purpose have nothing to fear from discoveries about rich human nature. He disarms even the most menacing threats with clear thinking, common sense, and pertinent facts from science and history. Despite its popularity among intellectuals during much of the twentieth century, he argues, the doctrine of the Blank Slate may have done more harm than good. It denies our common humanity and our individual preferences, replaces hardheaded analyses of social problems with feel-good slogans, and distorts our understanding of government, violence, parenting, and the arts.”

An interview with Pinker regarding this book is online as “A Biological Understanding Of Human Nature: A Talk With Steven Pinker” at

<[http://www.edge.org/3rd\\_culture/pinker\\_blank/pinker\\_blank\\_print.html](http://www.edge.org/3rd_culture/pinker_blank/pinker_blank_print.html)>.

According to Hemel’s (2005b) interview with Lawrence Summers, Summers’ speculation on innate gender differences in math/science abilities came from scholars cited in Pinker’s (2003) *The Blank Slate: The Modern Denial of Human Nature*. According to reference 20 in the AWM’s (2005) petition background, among the scholars cited by Pinker are Hedges and Nowell (1995) and Lubinski and Benbow (1992).

#EB #SSIGD #SDMA Pinker, S. & E. Spelke. 2005. "The Science Of Gender And Science - Pinker vs. Spelke - A Debate on the research on mind, brain, and behavior that may be relevant to gender disparities in the sciences, including the studies of bias, discrimination and innate and acquired difference between the sexes," online at

<[http://www.edge.org/3rd\\_culture/debate05/debate05\\_index.html](http://www.edge.org/3rd_culture/debate05/debate05_index.html)>. See also Pinker (2003) and a video of the debate at <[http://www.edge.org/3rd\\_culture/bios/pinker.html](http://www.edge.org/3rd_culture/bios/pinker.html)>. An excerpt from the Introduction to the debate is as follows:

"On April 22, 2005, Harvard University's Mind/Brain/Behavior Initiative (MBB) held a defining debate on the public discussion that began on January 16th with the public comments by Lawrence Summers, president of Harvard, on sex differences between men and women and how they may relate to the careers of women in science. The debate at MBB, 'The Gender of Gender and Science' was 'on the research on mind, brain, and behavior that may be relevant to gender disparities in the sciences, including the studies of bias, discrimination and innate and acquired difference between the sexes.' It's interesting to note that since the controversy surrounding Summers' remarks began, there has been an astonishing absence of discussion of the relevant science...you won't find it in the hundreds and hundreds of articles in major newspapers; nor will find it in the Harvard faculty meetings where the president of the leading University in America was indicted for presenting controversial ideas. . . . . But unlike just about anything else said about Summers' remarks, the debate, 'The Science of Gender and Science,' between Harvard psychology professors Steven Pinker and Elizabeth Spelke, focused on the relevant scientific literature. It was both interesting on facts but differing in interpretation (sic)."

An interesting excerpt of Pinker's side of the debate is as follows:

"For those of you who just arrived from Mars, there has been a certain amount of discussion here at Harvard on a particular datum, namely the under-representation of women among tenure-track faculty in elite universities in physical science, math, and engineering. . . . . Here are some recent numbers: Percentages of female faculty in tenure track positions in elite universities: Math: 8.3%, Chemistry: 12.1%, Chemical Engineering: 10.5%, Physics: 6.6%, Mechanical Engineering: 6.7%, Electrical Engineering: 6.5%, Civil Engineering: 9.8%, Computer Science: 10.6%, Astronomy: 12.6%. . . . [Our insert – no source for these numbers is given.]

As with many issues in psychology, there are three broad ways to explain this phenomenon. One can imagine an extreme 'nature' position: that males but not females have the talents and temperaments necessary for science. Needless to say, only a madman could take that view. The extreme nature position has no serious proponents.

There is an extreme 'nurture' position: that males and females are biologically indistinguishable, and all relevant sex differences are products of socialization and bias.

Then there are various intermediate positions: that the difference is explainable by some combination of biological differences in average temperaments and talents interacting with socialization and bias.

Liz [Spelke] has embraced the extreme nurture position. . . . .Liz has said that there is 'not a shred of evidence' for the biological factor, that 'the evidence against there being an advantage for males in intrinsic aptitude is so overwhelming that it is hard for me to see how one can make a case at this point on the other side,' and that 'it seems to me as conclusive as any finding I know of in science.'

These are extreme statements — especially in light of the fact that an enormous amount of research, summarized in these and many other literature reviews, in fact points to a very different conclusion. I'll quote from one of them, a book called *Sex Differences in Cognitive Ability*. . . . [Diane Halpern (2000)]. . . . She is a respected psychologist, recently elected as president of the American Psychological Association, and someone with no theoretical axe to grind. She does not subscribe to any particular theory, and has been a critic, for example, of evolutionary psychology. And here is what she wrote in the preface to her book:

‘At the time I started writing this book it seemed clear to me that any between sex differences in thinking abilities were due to socialization practices, artifacts, and mistakes in the research. After reviewing a pile of journal articles that stood several feet high, and numerous books and book chapters that dwarfed the stack of journal articles, I changed my mind. The literature on sex differences in cognitive abilities is filled with inconsistent findings, contradictory theories, and emotional claims that are unsupported by the research. Yet despite all the noise in the data, clear and consistent messages could be heard. There are real and in some cases sizable sex differences with respect to some cognitive abilities. Socialization practices are undoubtedly important, but there is also good evidence that biological sex differences play a role in establishing and maintaining cognitive sex differences, a conclusion I wasn't prepared to make when I began reviewing the relevant literature.’ ”

#SDMA Reilly, M. 2007b. “Women in STEM Careers” [Review of Byers & Williams (2006), Marzabadi *et al.* (2006), & Ceci & Williams (2006)], *AWIS Magazine*, Spring, online at <<http://www.awis.org/pubs/documents/AWISmagSpring2007.pdf>> (2.8 MB).

#SDMA Spelke, E.S. 2005. “Sex differences in intrinsic aptitude for mathematics and science?: A critical review.” *American Psychologist* 60(9): 950-958; online at <<http://www.wjh.harvard.edu/~lds/pdfs/spelke2005.pdf>> (176 kB). The abstract reads: “This article considers 3 claims that cognitive sex differences account for the differential representation of men and women in high-level careers in mathematics and science: (a) males are more focused on objects from the beginning of life and therefore are predisposed to better learning about mechanical systems; (b) males have a profile of spatial and numerical abilities producing greater aptitude for mathematics; and (c) males are more variable in their cognitive abilities and therefore predominate at the upper reaches of mathematical talent. Research on cognitive development in human infants, preschool children, and students at all levels fails to support these claims. Instead, it provides evidence that mathematical and scientific reasoning develop from a set of biologically based cognitive capacities that males and females share. These capacities lead men and women to develop equal talent for mathematics and science.”

Elizabeth Spelke <<http://www.wjh.harvard.edu/~lds/index.html?spelke.html>> is a Harvard cognitive psychologist. She maintains a “Sex & Science” webpage <<http://www.wjh.harvard.edu/~lds/sextsci/>>, has been profiled in the New Yorker <[http://www.newamerica.net/publications/articles/2006/the\\_baby\\_lab](http://www.newamerica.net/publications/articles/2006/the_baby_lab)>, and appears in the Wikipedia at <[http://en.wikipedia.org/wiki/Elizabeth\\_Spelke](http://en.wikipedia.org/wiki/Elizabeth_Spelke)>. For her debate with Steven Pinker see Pinker & Spelke (2005).

#SDMA Spelke, E.S. & A.D. Grace. 2006. "Sex, Math, and Science," in Ceci & Williams (2006). See also Pinker & Spelke (2005): "The Science Of Gender And Science - Pinker vs. Spelke - A Debate."

#SDMA Stage, E.K. & R. Karplus. 1981. "Mathematical Ability: Is Sex a Factor?" *Science* **212**: 114; online to subscribers at <<http://www.sciencemag.org/cgi/reprint/212/4491/118-a>>.

#SDMA Stanley, J.C. 1997. "Amazing academic achievement," *Johns Hopkins Magazine* **49**(4): 6, September; online at <<http://www.jhu.edu/~jhumag/0997web/letters.html>>. Stanley wrote:

"The facts are as follows: in 1981 there were 28 boys and no girls who in SMPY's annual search scored 700 or more on SAT-M before age 13. That was a low year, however. In 1980 there had been 15 boys and 5 girls. The usual male-to-female ratio at that score level nowadays is about 4 to 1. During the early 1980s it was 12 to 1, so girls appear to be doing increasingly better compared with boys -- but have not nearly caught up with them yet."

#SSIGD #SDMA Summers, L.H. 2005. "Remarks at NBER Conference on Diversifying the Science & Engineering Workforce" [NBER = National Bureau of Economic Research]

<<http://www.nber.org/>>], transcript online at

<<http://www.president.harvard.edu/speeches/2005/nber.html>>. Summers said [our *italics*]:

"There are three broad hypotheses about the sources of the very substantial disparities that this conference's papers document and have been documented before with respect to the presence of women in high-end scientific professions. . . . the first is what I call the *high-powered job hypothesis*. The second is what I would call *different availability of aptitude at the high end*, and the third is what I would call *different socialization and patterns of discrimination in a search*. And in my own view, their importance probably ranks in exactly the order that I just described."

The second hypothesis "*different availability of aptitude at the high end*" drew the attention of academics, created a firestorm in the media, resulted in Summers' resignation, and is encapsulated in the following provocative excerpt from the transcript:

". . . why is the representation [of women] even lower and more problematic in science and engineering than it is in other fields. And here, you can get a fair distance, it seems to me, looking at a relatively simple hypothesis. It does appear that on many, many different human attributes - height, weight, propensity for criminality, overall IQ, mathematical ability, scientific ability - there is relatively clear evidence that whatever the difference in means - which can be debated - *there is a difference in the standard deviation, and variability of a male and a female population. And that is true with respect to attributes that are and are not plausibly, culturally determined.* [Our *italics*.] If one supposes, as I think is reasonable, that if one is talking about physicists at a top twenty-five research university, one is not talking about people who are two standard deviations above the mean. And perhaps it's not even talking about somebody who is three standard deviations above the mean. But it's talking about people who are three and a half, four standard deviations above the mean in the one in 5,000, one in 10,000 class. Even small differences in the standard deviation will translate into very large differences in the available pool . . . [our insert - the transcript has "substantially out" at this point and is probably garbled – Summers probably meant something like "at the high-end tail of the distribution"].

Our thanks to Moira McDermott for this reference, given on her site

<<http://www.gustavus.edu/~mmcdermo/women-science-links.html>> as "Transcript of Summers' remarks."

#SDMA Williams, W.M. 2002. "Women in Academe, and the Men Who Derail Them," *STATUS*, January, online at <<http://www.aas.org/cswa/status/statusJan02c.pdf>> (1.2 MB). See also Ceci & Williams (2006).

## N. Status of Women Faculty at MIT #MIT

#MIT Fitzpatrick, S.M. 1999. "The Protégé to Peer Transition," *AWIS Magazine* 28(3); online at <[http://www.jsmf.org/about/s/protege\\_to\\_peer\\_transition.htm](http://www.jsmf.org/about/s/protege_to_peer_transition.htm)>. Susan Fitzpatrick is Vice President of the James S. McDonnell Foundation <<http://www.jsmf.org/>> and a prolific author - see <<http://www.jsmf.org/about/spubs.htm>>. Fitzpatrick wrote:

"For some time, I have been mulling over an idea that one hurdle facing women in science is what I call 'the protégé to peer transition.' In a nutshell, I think one of the problems facing women is that men (and to a larger extent, society) are comfortable with women in subordinate roles, but less accepting of women as peers – or superiors. So while women no longer confront overt difficulties entering even the most competitive graduate schools or securing prestigious postdoctoral positions (both of which may provide opportunities for significant recognition and support), *there are still relatively few women scientists in tenured faculty positions or in more senior positions like chairs and deanships.* [Our *italics*.] Yet I was bothered by the fact that my ideas largely were based on anecdote and personal observation. I worried whether I would be able to write something more substantive, and whether I could support my theories with data. Remarkably, just as the deadline was looming—and I still hadn't found quite the right hook to hang my protégé/peer story on *A Study on the Status of Women Faculty in Science at MIT* hit the news . . .[MIT (1999)].

#MIT Kleinfeld, J. 1999. "MIT Tarnishes Its Reputation with Gender Junk Science," online at <<http://www.uaf.edu/northern/mitstudy/mittarn.pdf>> (188 kB). This appears on the "Independent Women's Forum (IWF) website – see IWF (2008).

#MIT MIT. 1999. "A Study on the Status of Women Faculty at MIT," MIT Faculty Newsletter XI (4), March; online at <<http://web.mit.edu/fnl/women/women.html>>.

#MIT Urry, M. 2001. "Criticism and Defense of the MIT Report," *STATUS*, June; online at <[http://www.aas.org/cswa/status/status\\_jun01.pdf](http://www.aas.org/cswa/status/status_jun01.pdf)> (10 MB):

"MIT's admission two years ago that it had unintentionally discriminated against women was unprecedented. . . . Then came the follow-up meeting at MIT, attended by university presidents, chancellors, provosts, and 25 women faculty, representing top research universities. They met January 29, 2001 to discuss equitable treatment of women faculty in science and engineering. The statement issued by the leaders of the nine universities . . .Cal Tech, MIT, Michigan, Princeton, Stanford, Yale, Berkeley, Harvard, Pennsylvania . . . recognized that barriers to women still exist and promised to work for full and equal participation by women faculty in their institutions."

#MIT Wilson, R. 1999. "An MIT Professor's Suspicion of Bias Leads to a New Movement for Academic Women: Faculty members at other universities seek to apply her approach to promote gender equity," *The Chronicle of Higher Education*, December; online at <<http://chronicle.com/free/v46/15/15a00101.htm>>