CONSERVATISM AND REFORM: CHALLENGES TO HIGHER EDUCATION

Luiz Davidovich
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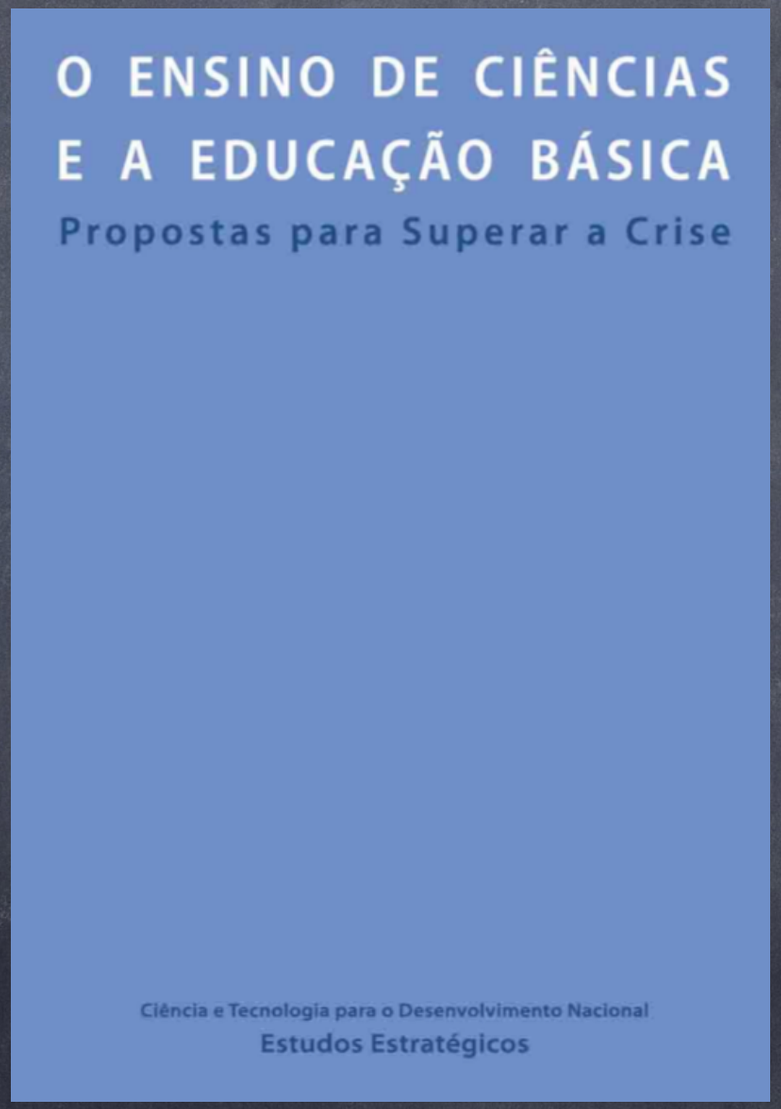
Universidade Federal do Rio de Janeiro

PUBLICATIONS OF THE BRAZILIAN ACADEMY OF SCIENCES



Available at www.abc.org.br

PUBLICATIONS OF THE BRAZILIAN ACADEMY OF SCIENCES

November 2004

Alaor Silvério Chaves (UFMG)
Carlos Alberto Aragão de Carvalho Filho (UFRJ)
Francisco César de Sá Barreto (UFMG)
Gilberto Cardoso Alves Velho (UFRJ)
João Alziro Herz da Jornada (UFRGS e INMETRO)
Luiz Bevilacqua (LNCC)
Luiz Davidovich (UFRJ – coordenador)
Moysés Nussenzveig (UFRJ)
Ricardo Gattass (UFRJ E FINEP)

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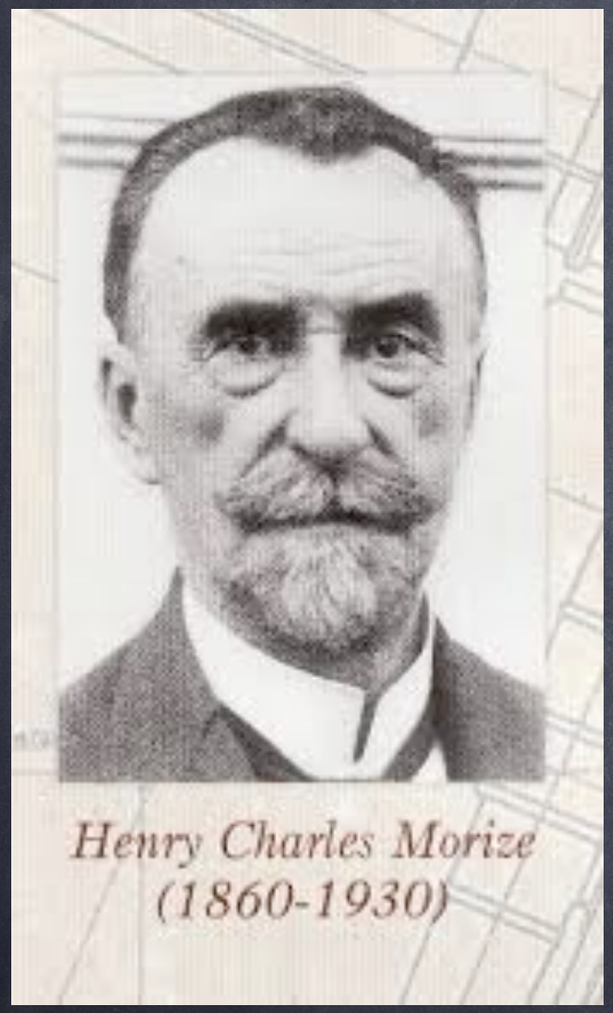
UMA CONSTATAÇÃO



"As nossas escolas superiores lutam com todas as dificuldades, de organização, de pessoal, de recursos, e estão neste instante dependentes de uma reforma que permanece como enorme incógnita".

Henrique Morize, fundador da Academia Brasileira de Ciências e seu primeiro Presidente, palestra no Clube de Professores, ca. 1920

("Henrique Morize e o Ideal de Ciência Pura na República Velha", Antonio Augusto Passos Videira, Editora FGV, 2003)

25 Anos
Ciência e Tecnologia
Ministério da Ciência e Tecnologia
1985 - 2010

BRASIL
UM PAÍS DE TODOS

4ª CNCTI

Conferência Nacional de Ciência, Tecnologia e Inovação

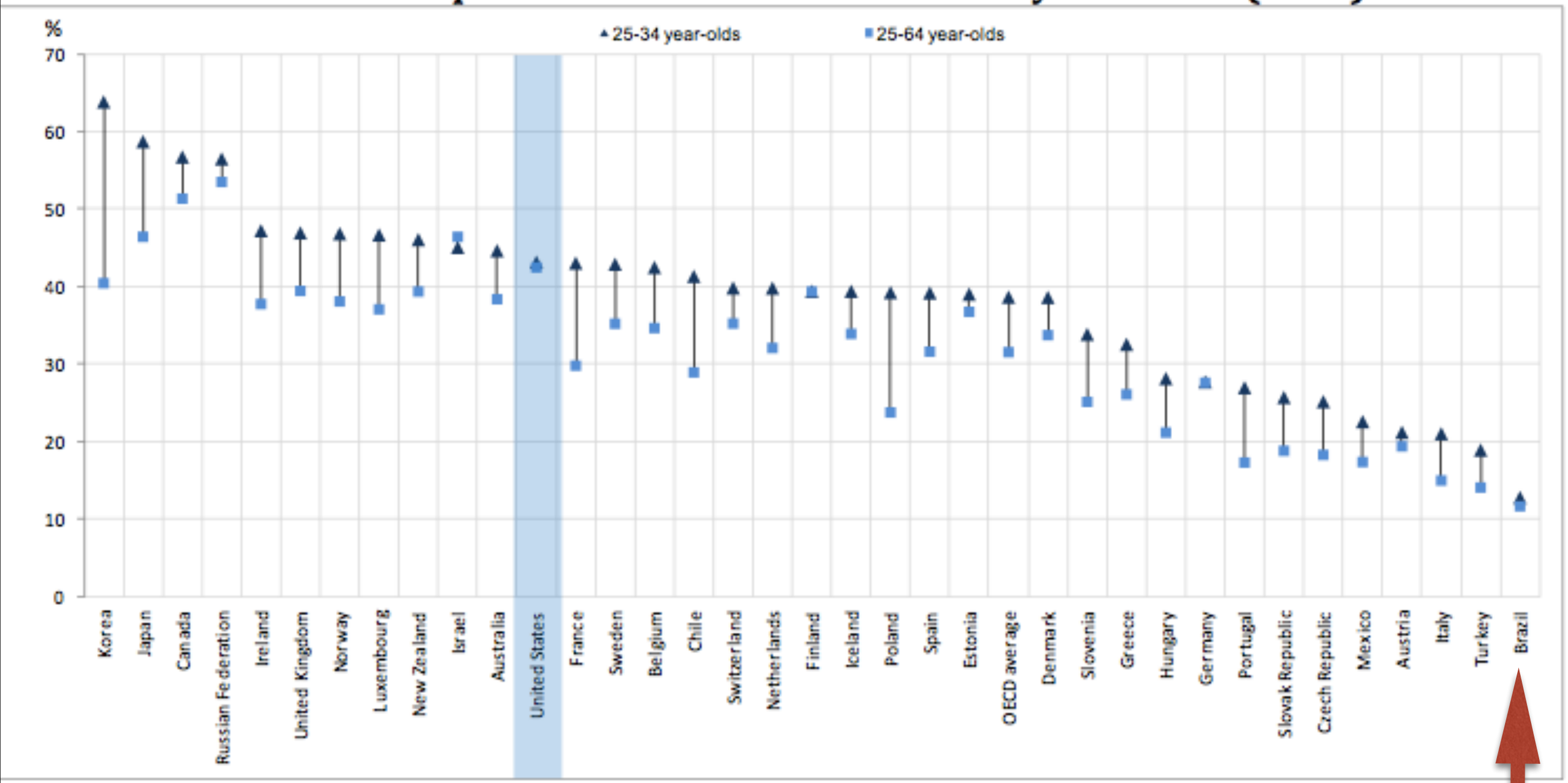
Fourth National Conference on Science, Technology, and Innovation - May 2010

OUTLOOK

1. Situation of education, Brazil and World
2. Scientists and engineers, Brazil and World
3. Higher education reform, Brazil and World

1. Situation of education, Brazil and World

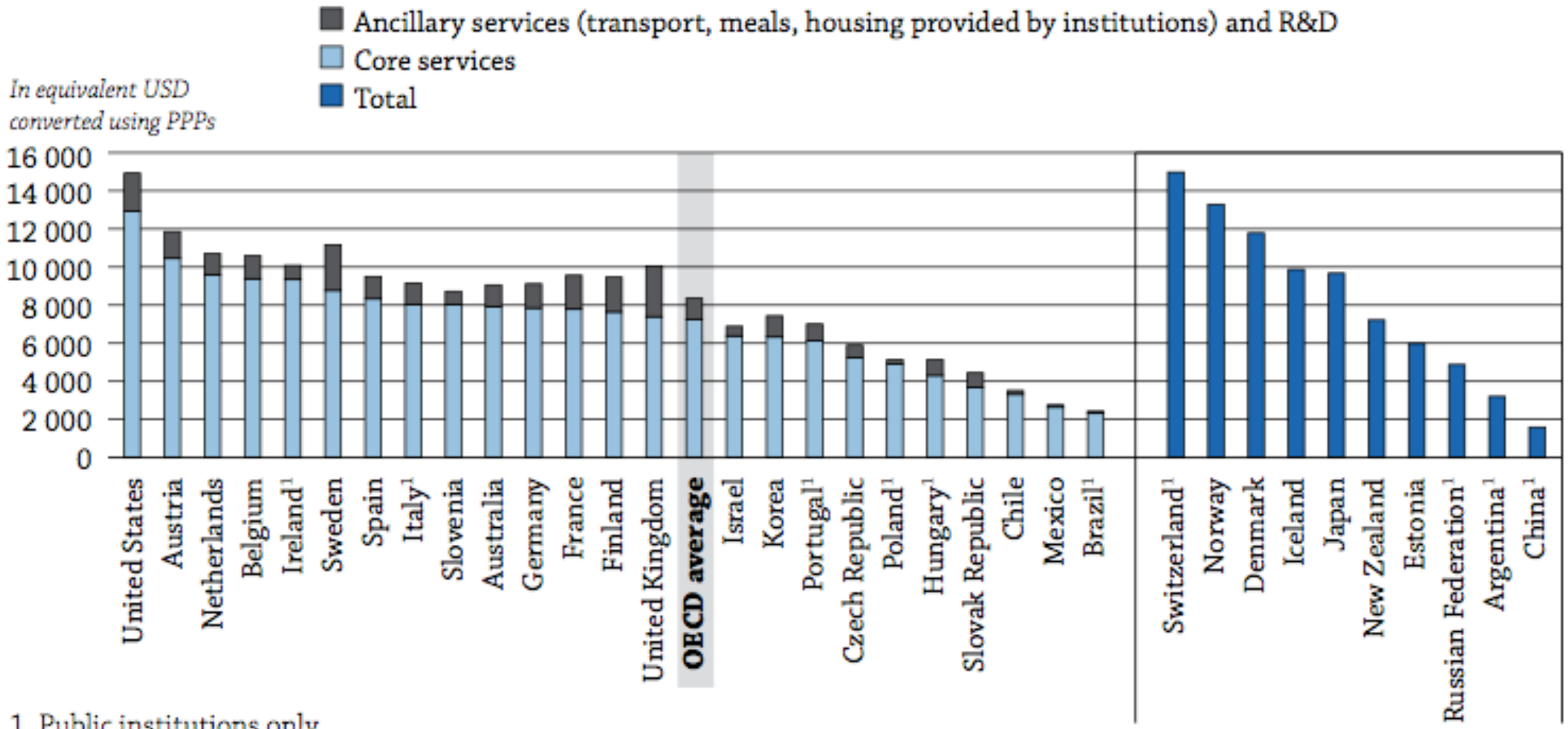
Chart A1.1. Population that has attained tertiary education (2011)



Countries are ranked in descending order of the percentage of 25-34 year-olds who have attained tertiary education.
Source: OECD. Table A1.3a. See Annex 3 for notes (www.oecd.org/edu/eag.htm)

Brasil, 2004 — 25-34: 9%

Chart B1.1. Annual expenditure per student by educational institutions from primary through tertiary education, by type of services (2008)



1. Public institutions only.

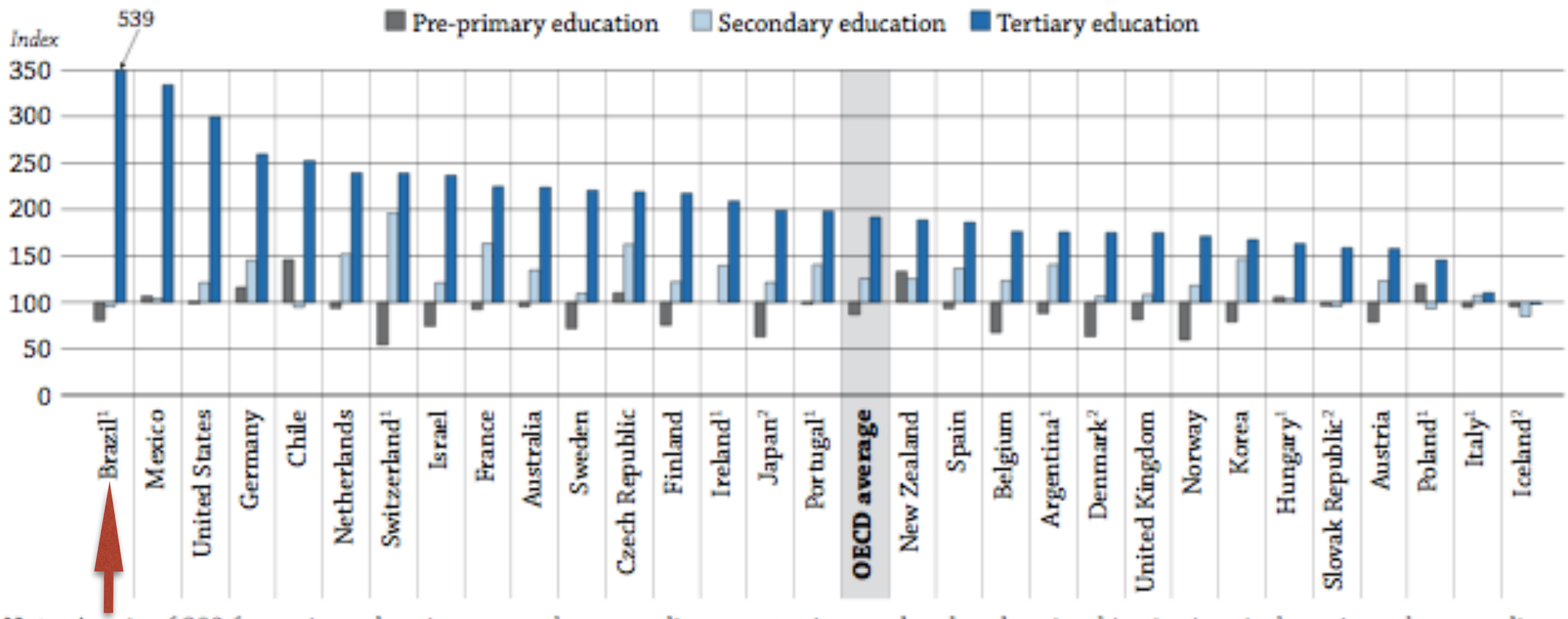
Countries are ranked in descending order of expenditure per student by educational institutions for core services.

Source: OECD. Argentina: UNESCO Institute for Statistics (World Education Indicators Programme). China: China Educational Finance Statistics Yearbook 2009. Table B1.2. See Annex 3 for notes (*www.oecd.org/edu/eag2011*).

EDUCATION AT A GLANCE 2011

Chart B1.3. Expenditure per student by educational institutions at various levels of education for all services relative to primary education (2008)

Primary education = 100



Note: A ratio of 300 for tertiary education means that expenditure per tertiary student by educational institutions is three times the expenditure per primary student by educational institutions.

A ratio of 50 for pre-primary education means that expenditure per pre-primary student by educational institutions is half the expenditure per primary student by educational institutions.

1. Public institutions only (for Italy, except in tertiary education).
2. Some levels of education are included with others. Refer to "x" code in Table B1.1a for details.

Countries are ranked in descending order of expenditure per student by educational institutions in tertiary education relative to primary education.

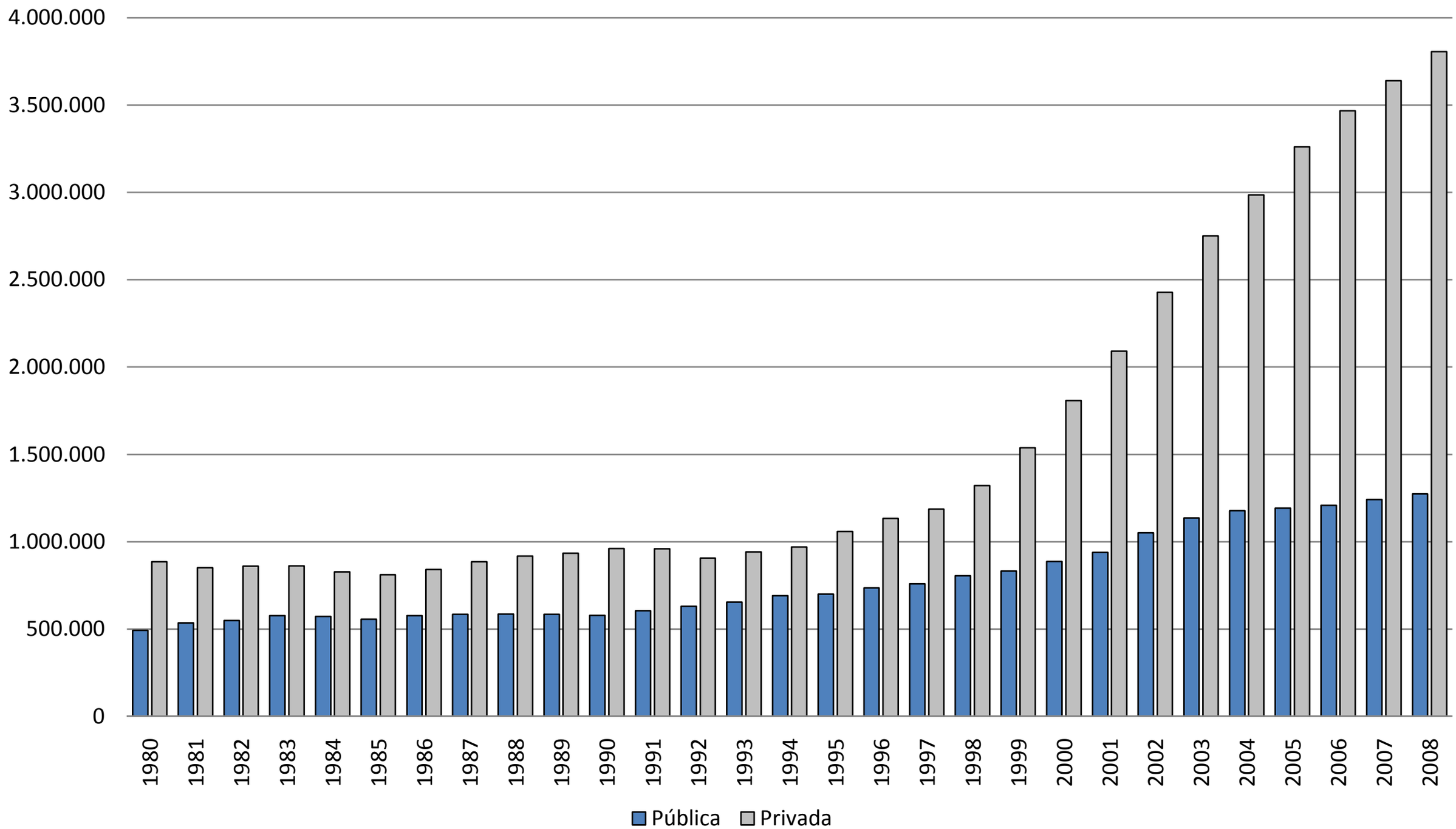
Source: OECD. Argentina: UNESCO Institute for Statistics (World Education Indicators Programme). Table B1.1a. See Annex 3 for notes (*www.oecd.org/edu/eag2011*).

EDUCATION AT A GLANCE 2011

Insper | Instituto de Ensino e Pesquisa

Gráfico 33

Total de matrículas - Brasil 1980-2008 (Censo) - Pública e Privada

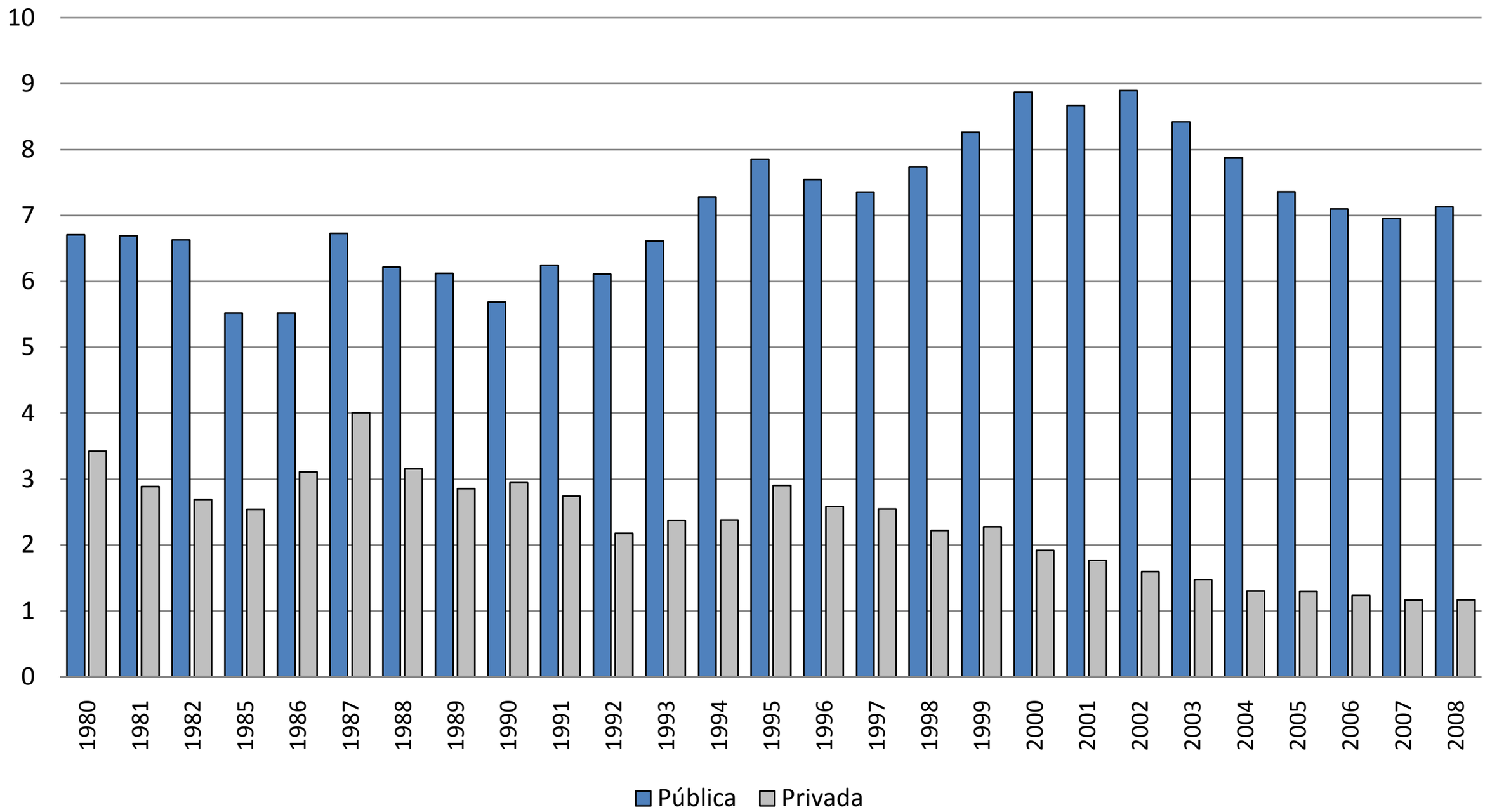


Fonte: Censo Superior. Elaboração Própria

Insper | Instituto de Ensino e Pesquisa

Gráfico 36

Relação de candidatos por vaga em cursos de graduação presenciais - Brasil 1980-2008 - (Censo)



Fonte: Censo Superior. Elaboração Própria

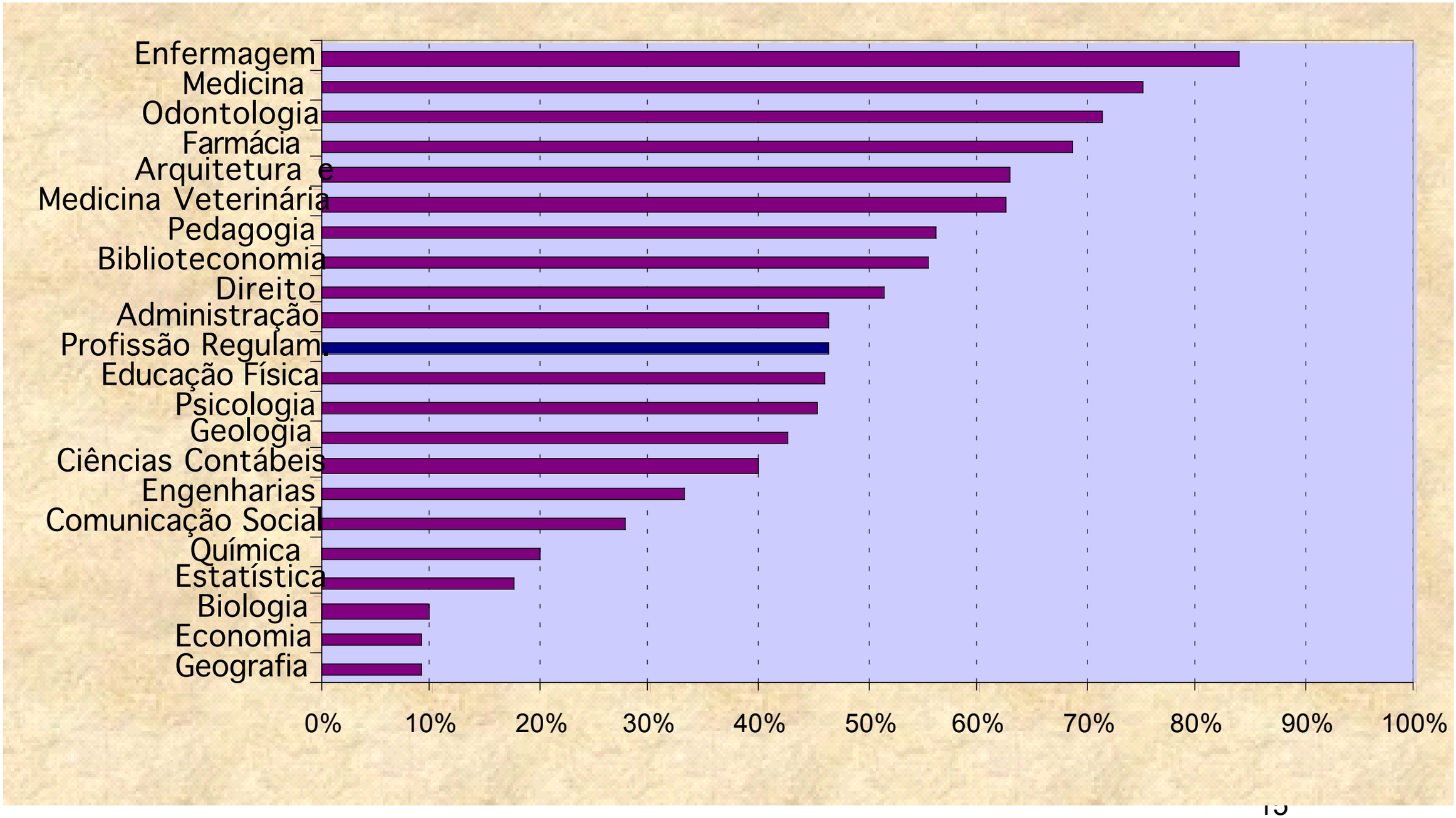
2. Scientists and engineers, Brazil and World

SCIENTISTS AND ENGINEERS

BRAZIL: 6% of graduates are engineers - 48.000 per year in 2008
CHINA: 35% - more than 600.000 engineers per year (including graduates in two- and three-year colleges)
INDIA - 220.000
RUSSIA - 190.000

BRAZIL: 15% of the researchers in enterprises has a master or Ph. D. degree
SOUTH KOREA: 39% (6% PH. D's and 33% masters)

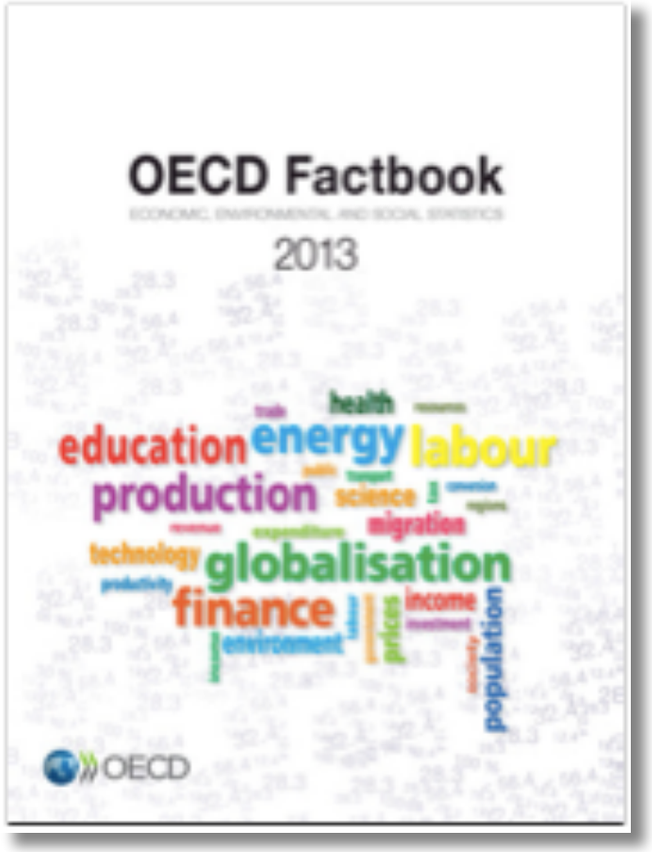
PEOPLE 23 YEARS OLD OR MORE WORKING IN THE AREA OF TRAINING



Fonte: Tabulação do Observatório Universitário com os microdados do Censo Demográfico de 2000 do IBGE

RESEARCHERS PER THOUSAND PEOPLE, FULL-TIME EQUIVALENT

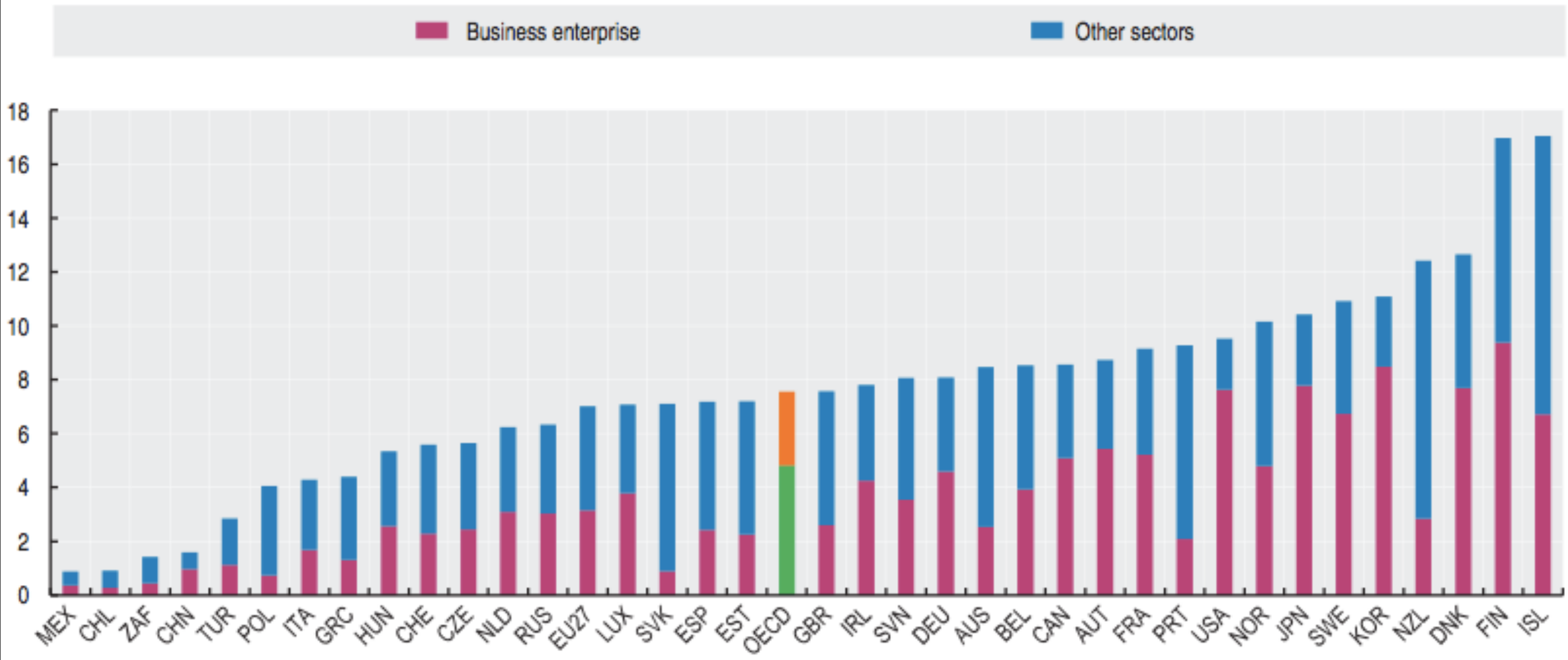
	1998	2010
Finland	13.9	17.0
Korea	4.6	11.1
Germany	6.3	8.1
Hungary	2.9	5.3
USA	9.3	
Spain	4.0	7.2
Turkey	1.0	2.9
China	0.7	1.6
Russia	8.4	6.3
South Africa	1.3 (2001)	1.4 (2008)
Brazil		1.2



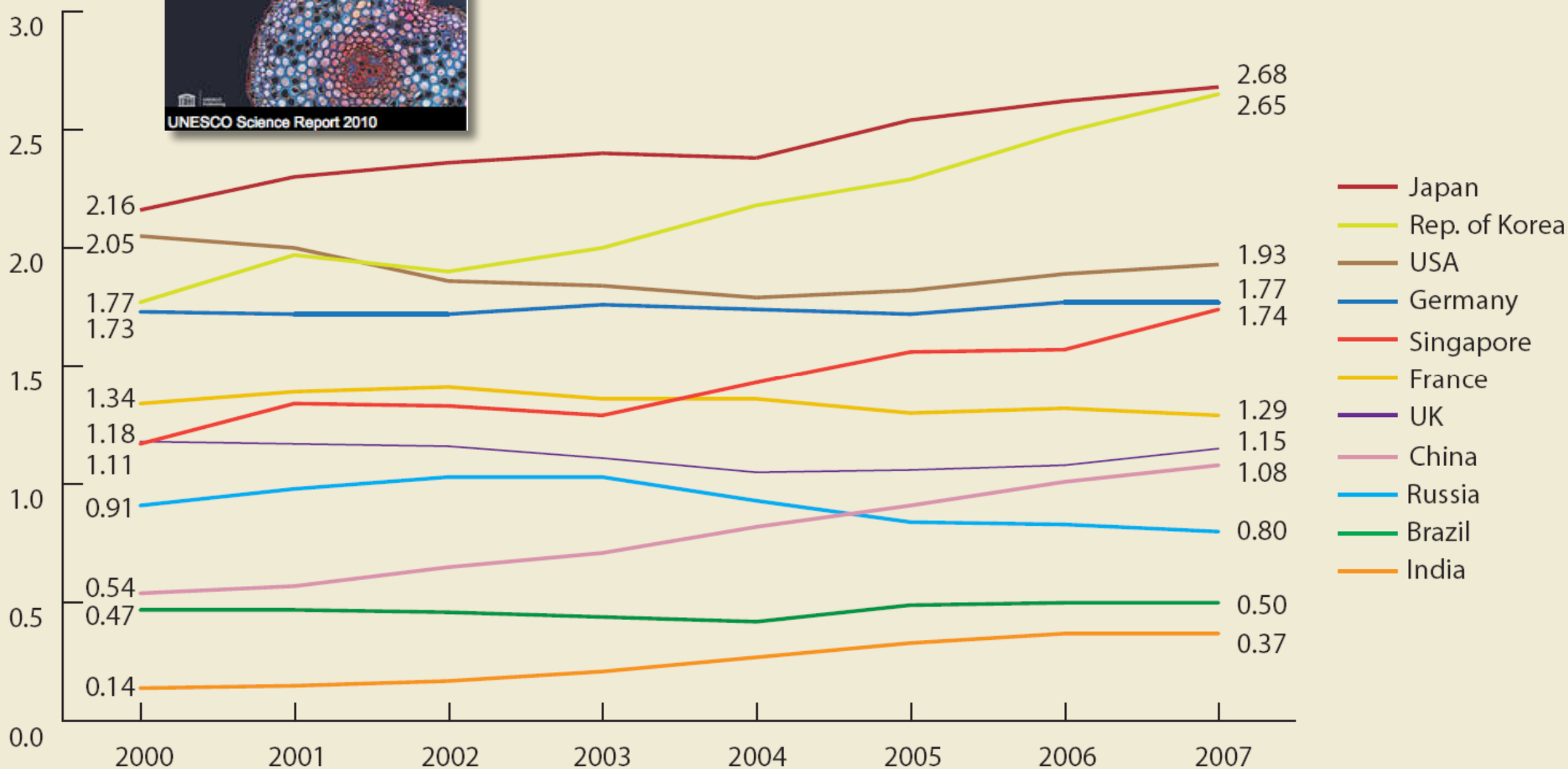
OECD average: 7,6 researchers per thousand people

Researchers

Per thousand employed, full-time equivalent



BUSINESS SPENDING IN R&D/GNP



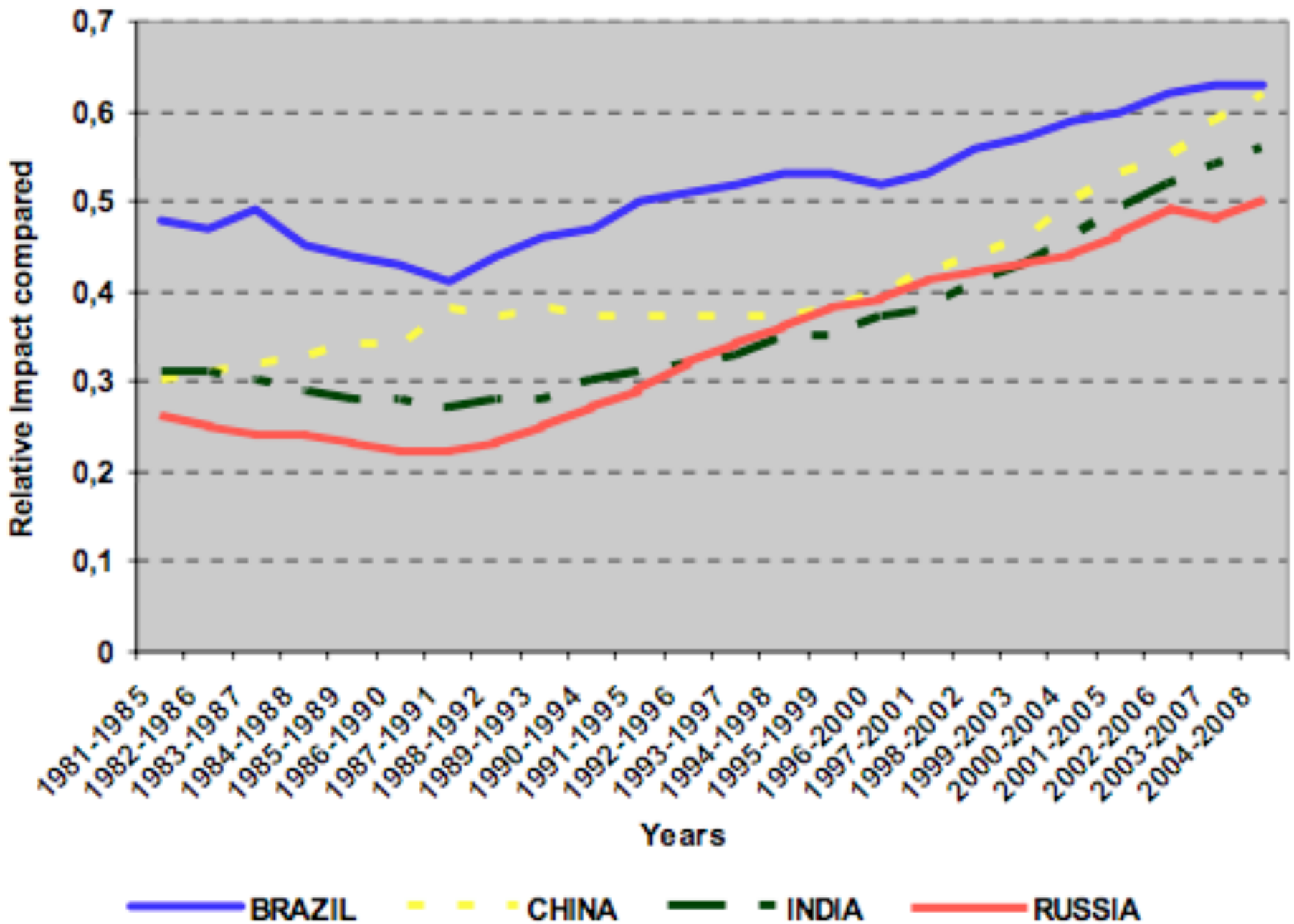
Source: UNU-MERIT based on data from UNESCO Institute for Statistics

Tabela 6. Scientific Production: 22 Standard Fields - Brazil X World 2004 - 2008*

	STANDARD FIELDS	WORLD			BRAZIL			
		Papers Number	Citations	Impact	Papers Number	% World	Citations	Impact
1	Agricultural Sciences	99,744	285,478	2,9	5,376	5,4	7,368	1,4
2	Biology & Biochemistry	272,33	2.009.527	7,4	5,867	2,2	20,019	3,4
3	Chemistry	587,028	2.977.516	5,1	10,478	1,8	34,829	3,3
4	Clinical Medicine	1.008.201	5.807.706	5,8	18,408	1,8	71,648	3,9
5	Computer Science	150,142	226,897	1,5	2,034	1,4	1,922	0,9
6	Economics & Business	73,287	155,873	2,1	377	0,5	429	1,1
7	Engineering	395,352	780,988	2,0	5,753	1,5	10,844	1,9
8	Environment/Ecology	131,825	583,609	4,4	3,578	2,7	12,240	3,4
9	Geosciences	136,314	536,513	3,9	1,971	1,5	6,346	3,2
10	Immunology	60,152	596,174	9,9	1,352	2,3	7,439	5,5
11	Materials Science	231,418	698,366	3,0	3,507	1,5	7,492	2,1
12	Mathematics	125,072	170,677	1,4	2,230	1,8	2,742	1,2
13	Microbiology	81,508	573,185	7,0	2,475	3,0	9,846	4,0
14	Molecular Biology & Genetics	138,303	1.566.285	11,3	2,506	1,8	9,133	3,6
15	Multidisciplinary	22,264	90,096	4,1	444	2,0	830	1,9
16	Neuroscience & Behavior	146,224	1.173.716	8,0	3,600	2,5	13,527	3,8
17	Pharmacology & Toxicology	90,877	492,839	5,4	2,578	2,8	8,660	3,4
18	Physics	467,316	1.943.951	4,2	10,860	2,3	40,319	3,7
19	Plant & Animal Science	270,294	857,683	3,2	12,561	4,7	19,434	1,6
20	Psychiatry/Psychology	119,744	509,368	4,3	1,034	0,9	2,656	2,6
21	Social Sciences, general	198,774	394,491	2,0	2,993	1,5	2,971	1,0
22	Space Science	59,699	426,221	7,1	1,281	2,2	7,174	5,6
	TOTAL DATA	4,865,868	22,857,159	4.7	101,263	2.2	297,87	2.9

* Source: National Swcience Indicators - Standard Data Base - ISI Thomson Reuters 2008

EVOLUTION OF IMPACT FACTORS

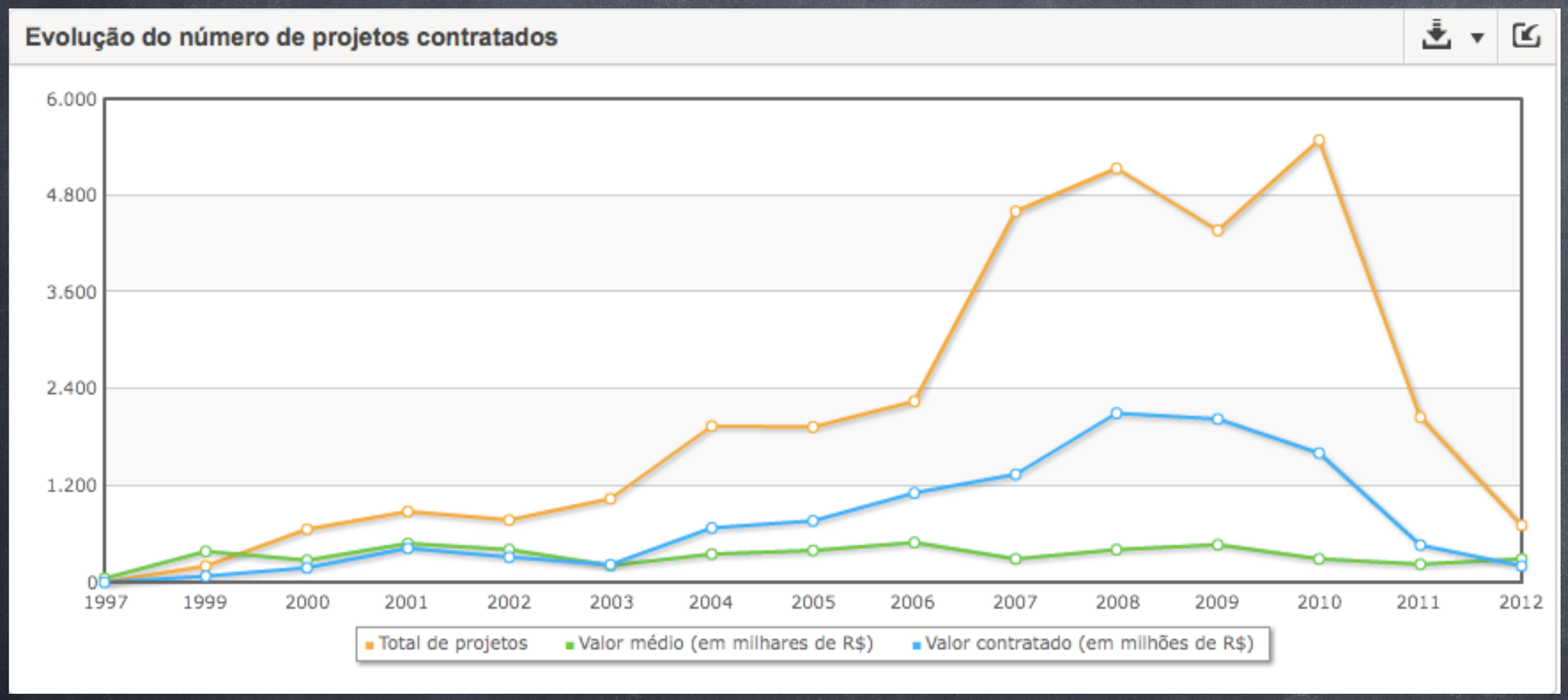


Source: Thomson Reuters National Science Indicators

EXCELLENCE IN HIGHER EDUCATION NEEDS EXCELLENCE IN RESEARCH...

Dilma fala em investimento de R$ 33 bi para Copa-14 e prevê 330 mil empregos

Sectoral funds



Ministro do Desenvolvimento, Indústria e Comércio

Brasil vai investir US$ 735 bilhões em infraestrutura, indústria e construção civil

Science and economic crisis

www.sciencemag.org on March 9, 2012

A Bumper Year for Chinese Science

Slowdown strategy. With a slackening economy in sight, Wen Jiabao says China will focus on research that boosts growth.

BEIJING—Another year, another chance for scientists here to pop the champagne corks. In a draft budget released on 5 March at the opening session of the annual National People's Congress, China has earmarked 32.45 billion yuan ($5.14 billion) for basic research in 2012—up 26% from last year's appropriation.

15 MARCH 2012 | VOL 483 | NATURE | 253

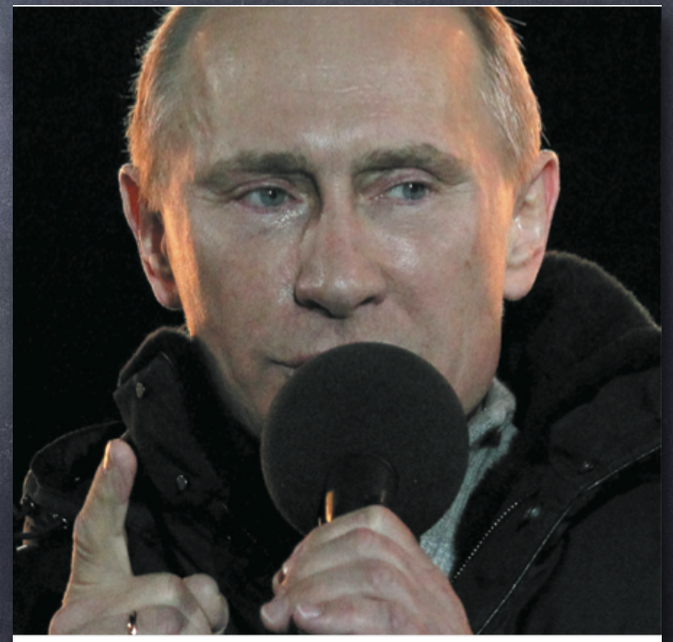
ScienceInsider

Breaking news and analysis from the world of science policy

Singh Promises Windfall for India's Scientists

by Pallava Bagla on 4 January 2012, 10:24 AM | 0 Comments

BHUBANESWAR, INDIA—India's Prime Minister Manmohan Singh has vowed to more than double his nation's spending on R&D over the next 5 years and build two major research facilities. The ambitious pledge, made here yesterday at the annual Indian Science Congress, is expected to be a highlight of the government's new 5-year plan now being finalized before its submission to parliament in March or April.



Vladimir Putin is proposing to set up world-class institutes and broaden distribution of research funding.

POLITICS

Putin promises science boost

But Russian researchers are sceptical of ambitious schemes.

3. Higher-education reform, Brazil and World

INTERNATIONAL MOVEMENT FOR REFORM

nature

www.nature.com/nature

Vol 446 | Issue no. 7139 | 26 April 2007

The university of the future

The traditional model of the US research university — based on the pre-eminence of the single-discipline department — needs to be stretched and challenged.

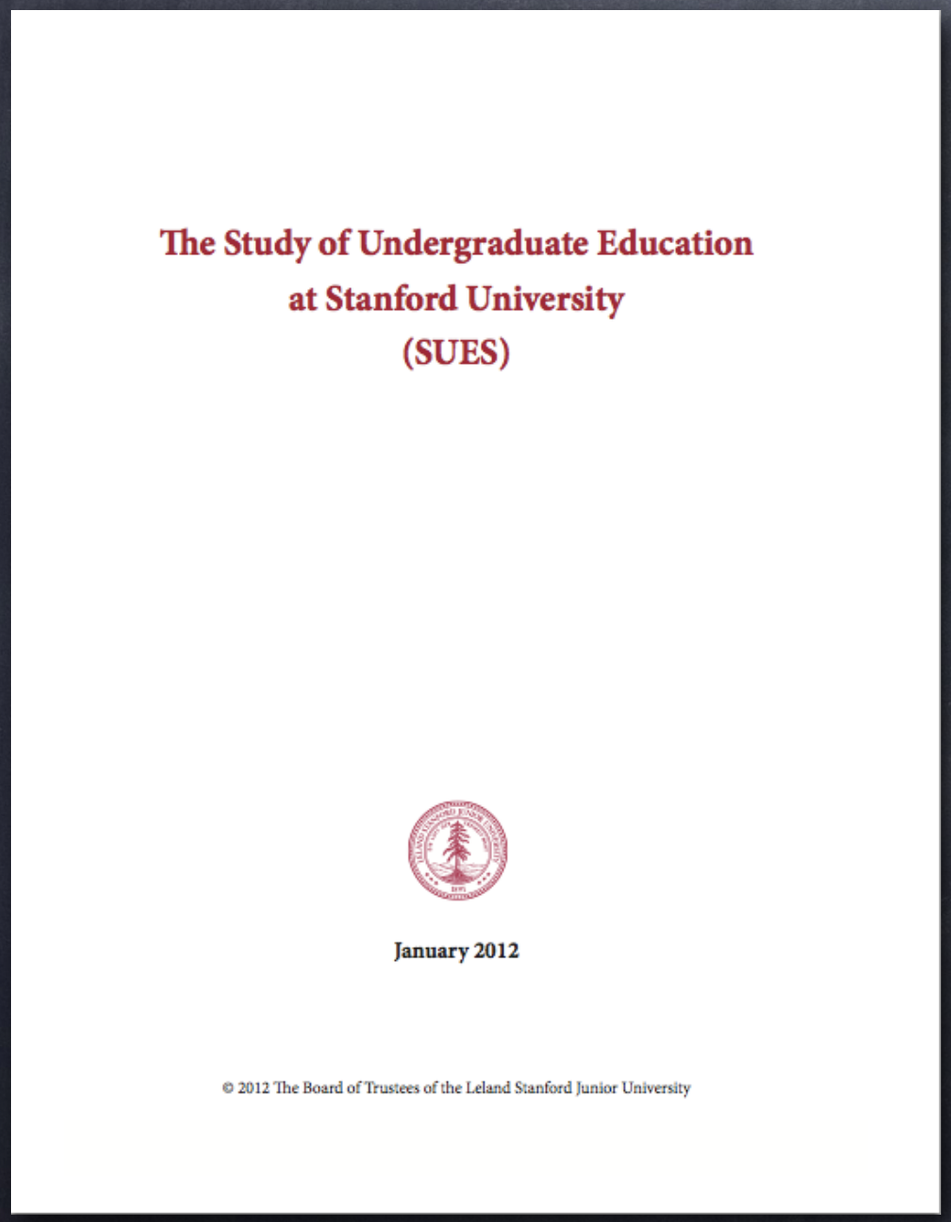
Role of Universities

- Robert Bayer, Department of Applied Physics, Stanford University, former Vice-President for Research of Stanford University, former member of Science and Technology Council of the State of California

"Q - What is Stanford´s role on the Silicon Valley boom?
A - The myth is that Stanford´s technology is what made Silicon Valley successful. However, a survey of 3000 small- company CEO's found only one in 20 companies used Stanford technology directly or indirectly in their start-up business. What Stanford contributed to Silicon Valley were educated, highly talented students."

Photonics Spectra, p. 24-25, April 1999

New guidelines...


The Study of Undergraduate Education
at Stanford University
(SUES)

January 2012

© 2012 The Board of Trustees of the Leland Stanford Junior University

"...the long-term value of an education to be found not merely in the accumulation of knowledge or skills but in the capacity to forge fresh connections between them.... Yet we were struck by how little attention most departments and programs have given to cultivating this essential capacity ... **If there is a single motivating principle that ties together the various recommendations that follow, it is our determination to breach the silos of students' lives,** to offer them an education that is more than the sum of its parts, an education equal to the unfathomable challenges and opportunities that await them."

Harvard: New guidelines...

- Lawrence Summers, President of Harvard, 2001-2006
- "An educational culture where it's an embarrassment to not know the names of five plays by Shakespeare but O.K. not to know the difference between a gene and a chromosome isn't functional."

New curriculum of HARVARD: Students must follow a course in each of the following groups ("activity-based learning"):

1. Aesthetic and interpretive understanding
2. Culture and belief
3. Empirical reasoning
4. Ethical reasoning
5. Science of living systems
6. Science of the physical universe
7. Societies of the world
8. The United States and the world

CHINA

“Entering the new century, leading universities in China have adopted a credit system, which allows more flexibility in learning. Along with curriculum renewal characterized by the tendency towards general education, universities have changed administration of student affairs. Students are expected to plan their learning and are provided with a more flexible curriculum. They can select their majors after one or two years of study. The rationale is to enhance all-round development. Since 1950s higher education in China had been professionally or specially oriented. During the years of planned economy, graduates were assigned to positions. The shift of the economic system changed the situation. Investigations show that only 50% of graduates are employed in accordance with their specialties (He and Pan 2003). Under this situation, universities have revised the curricula so that students can have more flexibility in individual development. The curricula are meant to be in the mean between professional education and general education. This direction of change has been welcomed by the students.” (Yang Zhong, Northeast Normal University, China)

CHINA

- Number of specializations offered by undergraduate courses in China was dropped in 1998 from 504 to 249.
- Shangai University, 2002: Increased flexibility, allowing students to fully match the needs of society with their own skills, interests, and talents.

NEW PARADIGMS FOR HIGHER EDUCATION

- Diversification of institutions of higher education, introduction of cycles (2-3 years) for undergraduate programs, with possibility of transference between different kinds of institutions

- Flexibility in curricula: solid and diversified education, more flexibility rather than introducing new specialized undergraduate courses

- Decrease in the number of hours in the classroom and number of mandatory disciplines, stimulate work outside classroom, more time to deal with excepcional students or students with learning problems. Time to work on thematic projects, to stimulate creativity, to think, to invent, to imagine!

- Delay specialization, stimulate interdisciplinary training and research, elective disciplines, special seminars on contemporary themes

ABOUT IMAGINATION...

"A imaginação é a memória que enlouqueceu."

(Imagination is the memory that went mad)

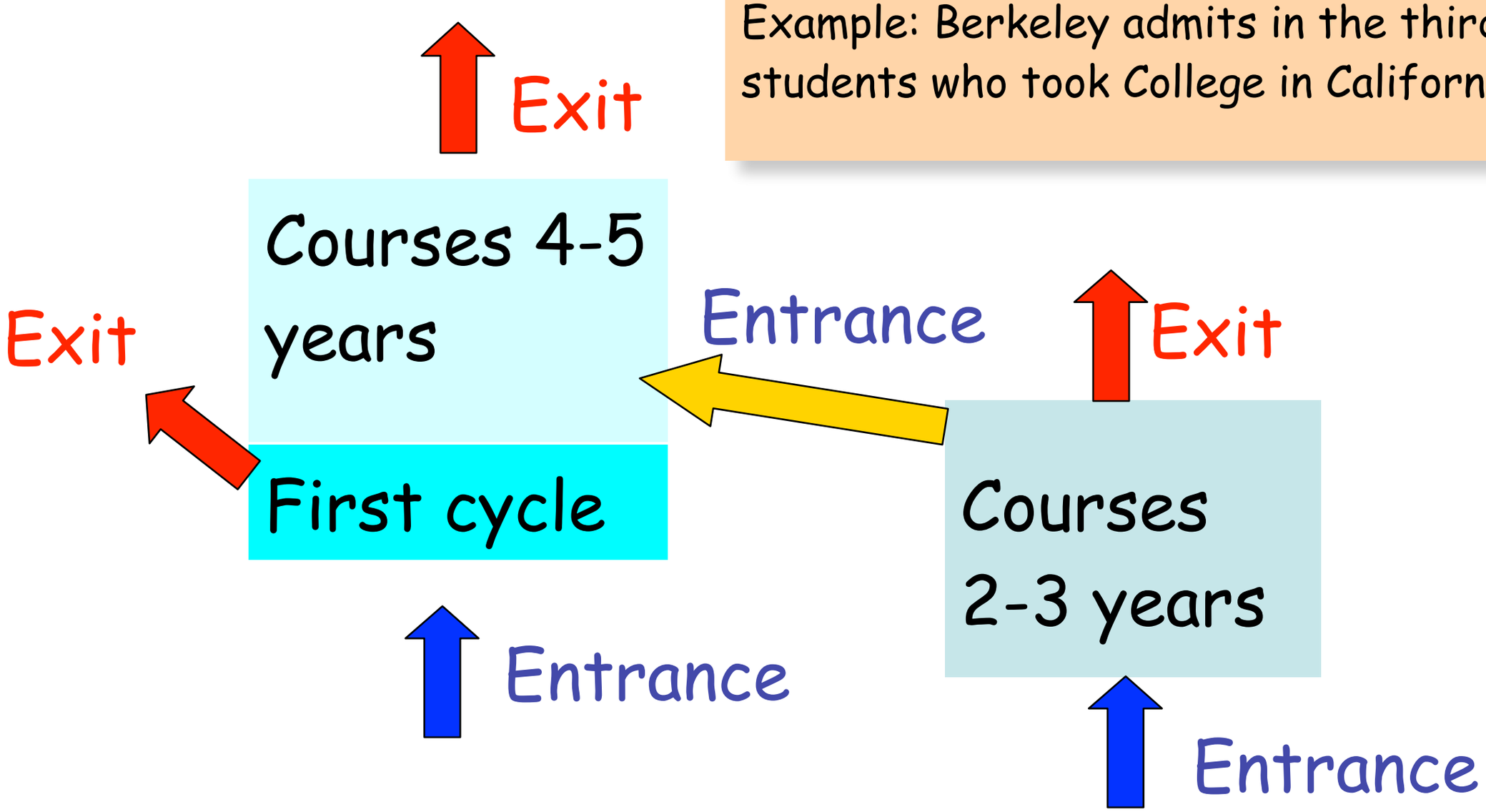
Mário Quintana (Brazilian poet, 1906-1994)

EXEMPLOS DE OFICINAS

- Biologia nos anos pós-genoma: onde está escrito o programa da vida?
- Evolução das espécies
- Fronteiras da Física: do microcosmo ao macrocosmo
- Mito, memória e história: entendendo os índios brasileiros
- Poetas brasileiros: leitura e comparação
- Racismo na sociedade brasileira
- Introdução à Astronomia: observando o céu
- Globalização: passado, presente e futuro
- Imaginação e ousadia na arquitetura brasileira
- Cidades brasileiras: políticas urbanas
- Geopolítica da Amazônia

DIVERSITY OF INSTITUTIONS AND TRAINING PATHS

Example: Berkeley admits in the third year students who took College in California



Credit transfer agreements

Flexibility of curricula

MIT Department of Physics

Undergraduate Program

Science Teaching

A relativity subject if not chosen under required subjects; otherwise, another core science subject beyond the GIRs

8.299 (arranged) Physics Teaching

11.124 (3-6-3) Introduction to Teaching and Learning Mathematics and Science

to satisfy the experimental requirement

8.13 (0-6-12) Experimental Physics I

Management

14.01 (3-0-9) Principles of Microeconomics

14.02 (3-0-9) Principles of Macroeconomics

15.501 (3-0-9) Introduction to Financial and Management Accounting

Medicine or Law

A set of subjects comprising part of a pre-medical or pre-law program

We suggest that the student consult with premed and pre-law advisors.

Flexibility of curricula

MIT Department of Physics

Undergraduate Program

Computer science

6.001 (5-3-7) Structure and Interpretation of Computer Programs
18.330 (3-0-9) Introduction to Numerical Analysis
6.042J (5-0-7) Mathematics for Computer Science

to satisfy the experimental requirement
8.13 (0-6-12) Experimental Physics I

Nanotechnology

8.231 (4-0-8) Physics of Solids I
6.152J (3-4-5) Microelectronics Processing Technology
6.781 (3-0-9) Submicrometer and Nanometer Technology

to satisfy the experimental requirement
Summer externship at Lucent Technologies, Bell Laboratories

Flexibility of curricula

MIT Department of Physics

Undergraduate Program

Astronomy

12.400 (3-0-9) The Solar System
8.284 (3-0-9) Modern Astrophysics
8.286 (3-0-9) The Early Universe

to satisfy the experimental requirement
12.410J (2-4-6) Observational Techniques of Optical Astronomy

Biophysics

7.03 (4-0-8) Genetics
7.05 (5-0-7) General Biochemistry
8.593J (formerly 8.515J) (4-0-8) Biological Physics

to satisfy the experimental requirement
7.02 (2-8-5) Introduction to Experimental Biology

Flexibility of curricula

MIT Department of Physics

Undergraduate Program

Philosophy of Science

8.06 (formerly 8.059) (3-0-9) Quantum Physics III
24.111 (3-0-9) Philosophy of Quantum Mechanics
24.215 (3-0-9) Topics in the Philosophy of Science

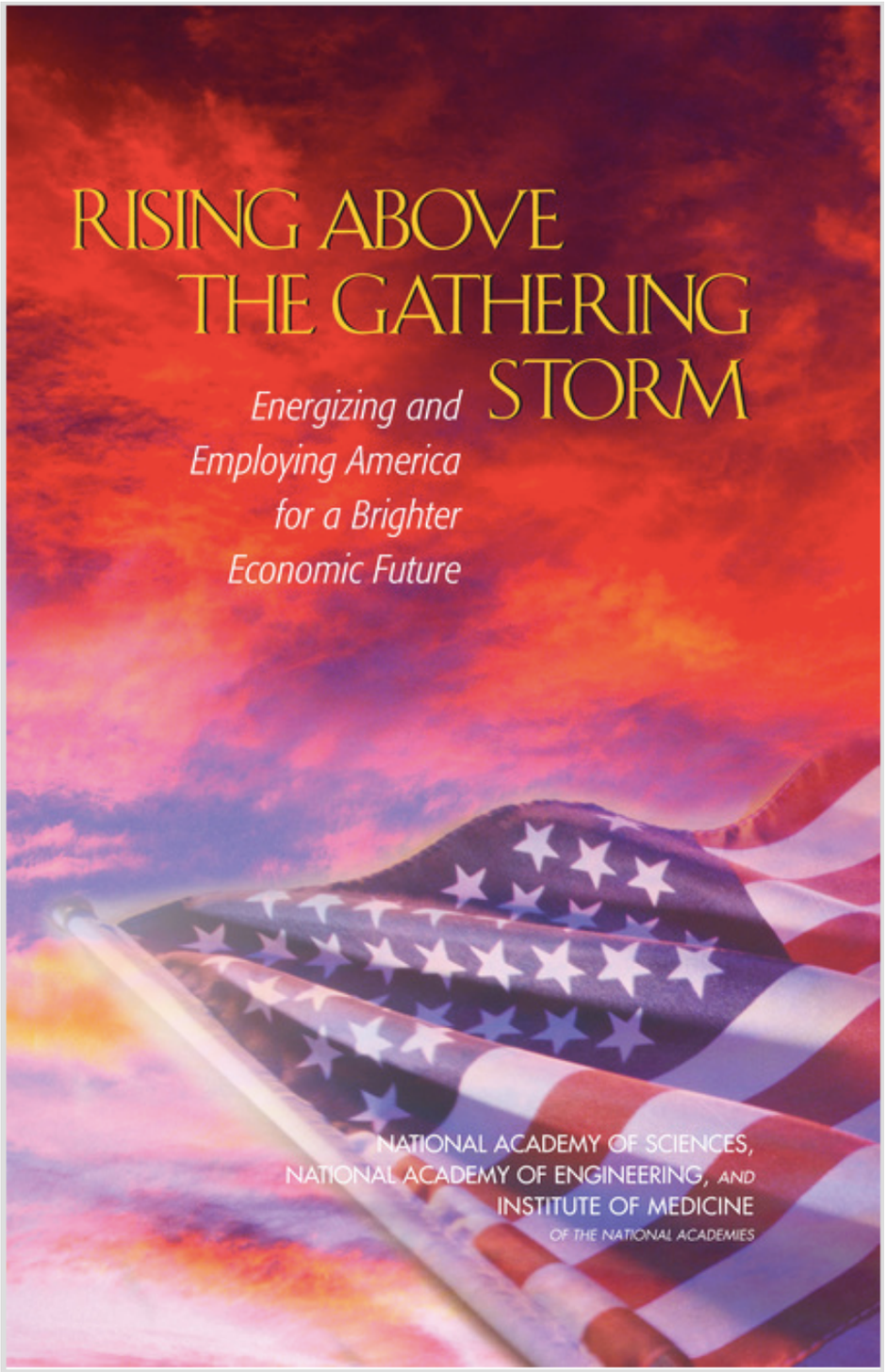
to satisfy the experimental requirement
8.13 (0-6-12) Experimental Physics I

History of Science

8.286 (3-0-9) The Early Universe
STS.003 (3-0-9) The Rise of Modern Science
STS.023J (2-6-4) Historic Experimentation

to satisfy the experimental requirement
8.13 (0-6-12) Experimental Physics I

CHALLENGES TO CHANGE



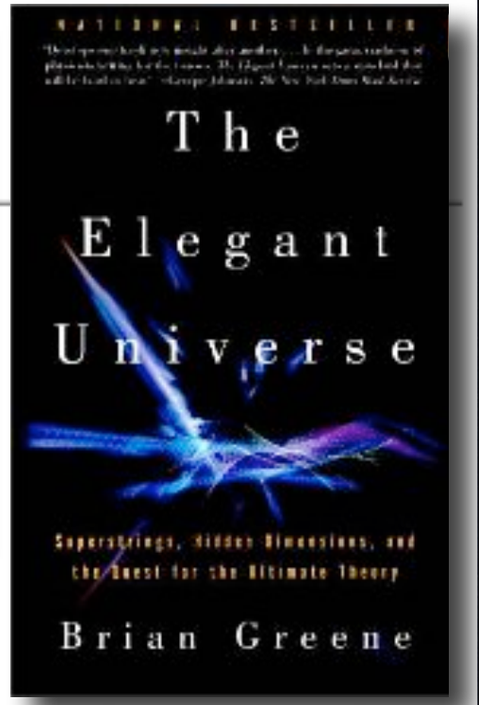
- Conservatism of corporations
- Precarious governance of educational institutions
- Precarious and unstable support for research
- Low quality of basic education and poor science education

U.S. Should Adopt Higher Standards for Science Education

Teachers, scientists and policymakers have drafted ambitious new education standards. All 50 states should adopt them

Jul 16, 2012

The New York Times
nytimes.con



June 1, 2008

OP-ED CONTRIBUTOR

Put a Little Science in Your Life

By BRIAN GREENE

A COUPLE of years ago I received a letter from an American soldier in Iraq. The letter began by saying that, as we've all become painfully aware, serving on the front lines is physically exhausting and emotionally debilitating. But the reason for his writing was to tell me that in that hostile and lonely environment, a book I'd written had become a kind of lifeline. As the book is about science — one that traces physicists' search for nature's deepest laws — the soldier's letter might strike you as, well, odd.

But it's not. Rather, it speaks to the powerful role science can play in giving life context and meaning.

It's the birthright of every child, it's a necessity for every adult, to look out on the world, as the soldier in Iraq did, and see that the wonder of the cosmos transcends everything that divides us.

Due to a subtle quirk of the evolution of the human species, the passion for science serves humanity, revolutionizes people's daily life, affects social organization, ways and costumes.

Thank you!