

# The Imperative for 21<sup>st</sup> Century Knowledge & Skills

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# Topics

- Economic disruptions to come due to offshoring and automation
- Need for Skills not just Knowledge, and Creativity in particular
- Importance of Science/Technology/Engineering/Math for innovation agendas

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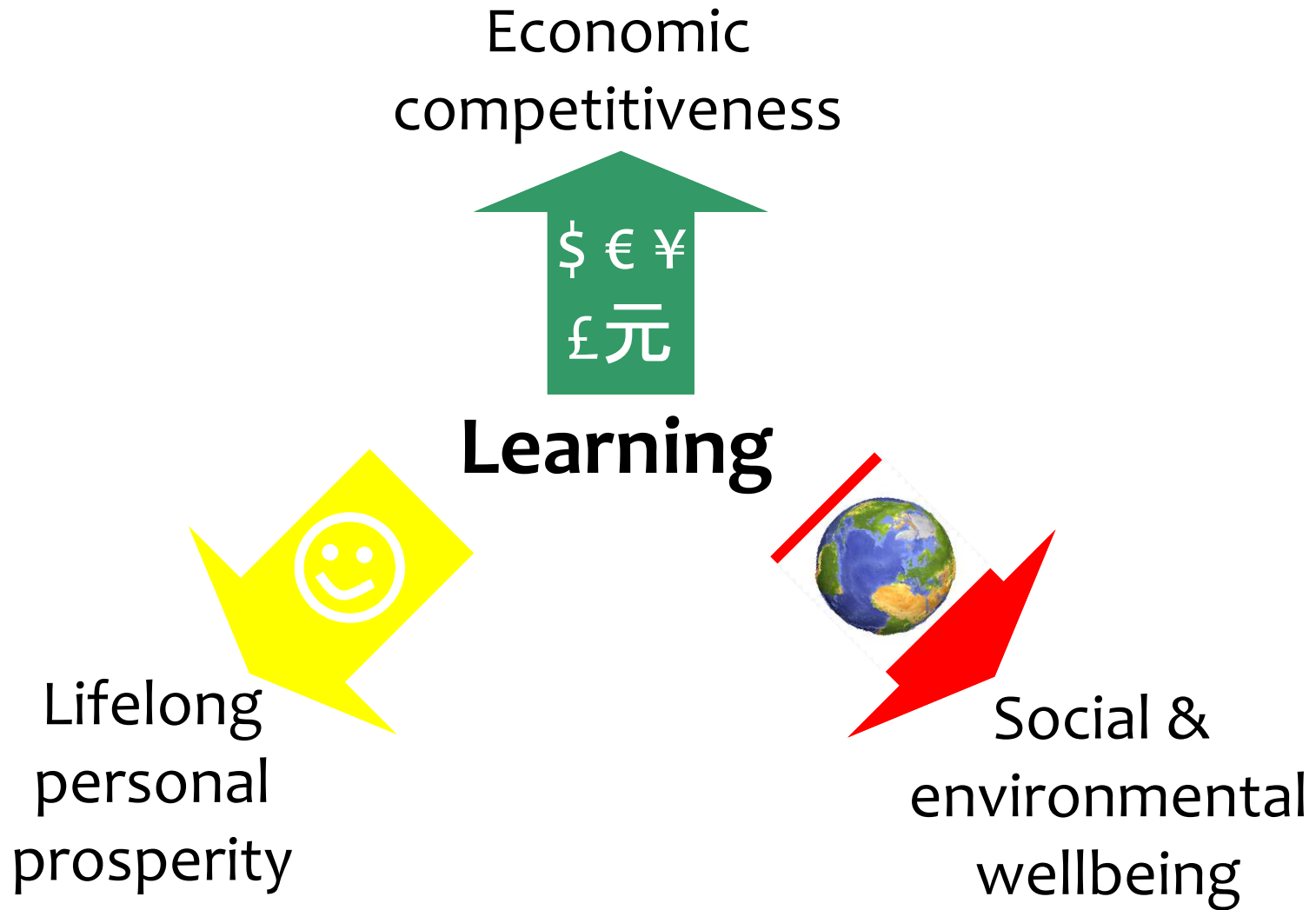
## Key Message

***RELEVANCE***

**Of**

**Education**

# The Benefits of Learning



# The New World We Live In



# What do these countries have in common ?

Egypt



Japan



Sweden



A: High Youth Unemployment

# Youth Bulge

1990's

Algeria  
Iraq  
Jordan  
Morocco  
Indonesia

2000's

Tajikistan  
Turkmenistan  
Egypt  
Iran  
Saudi Arabia  
Kuwait  
Sudan

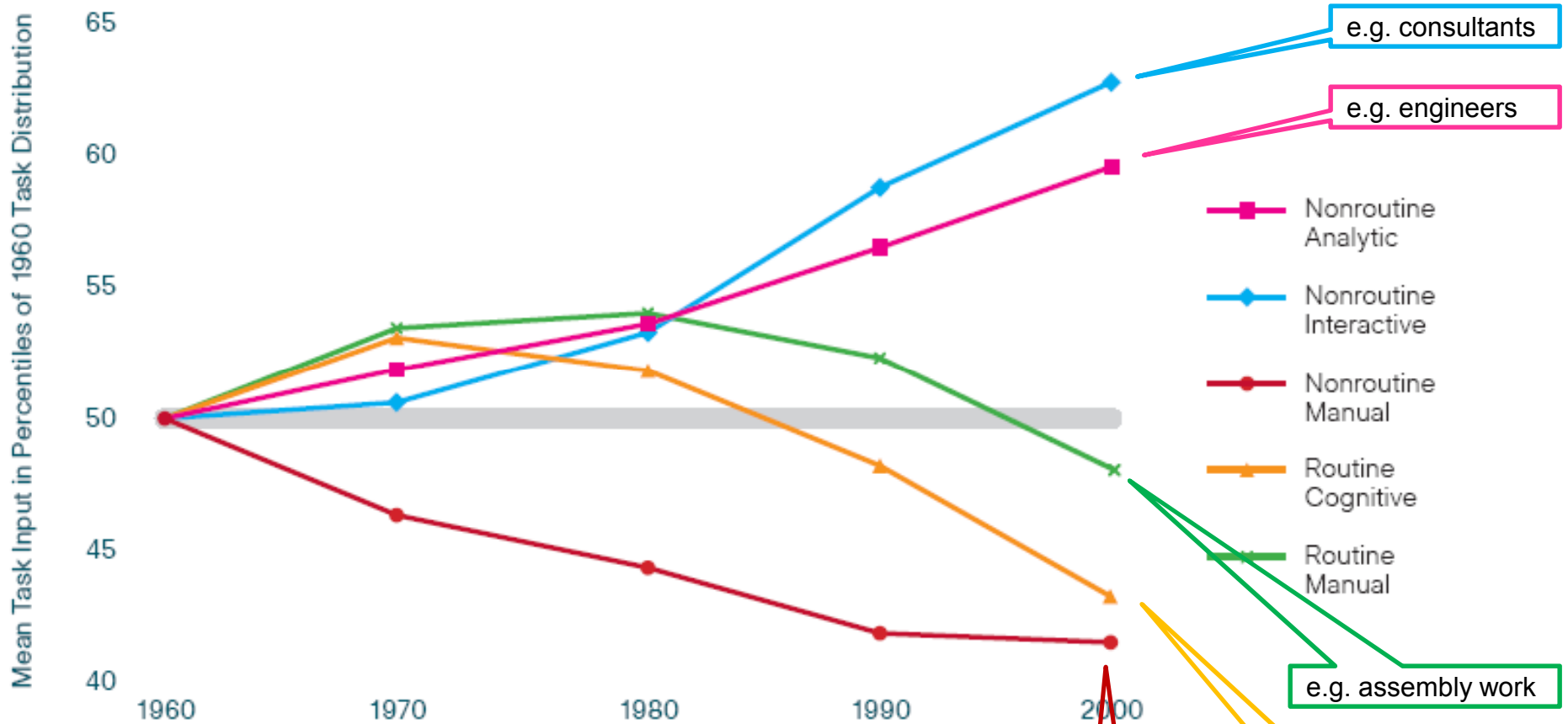
2010's

Kyrgyzstan  
Malaysia  
Pakistan  
Syria  
Yemen  
Jordan  
Iraq  
Oman  
Libya  
Afghanistan

Decades in which 15-24 years-old have peaked as a proportion of total population [>20%]; some happen twice. Source: 'The clash of civilizations' Samuel Huntington

# Accelerating Change Demands Different Skills

Economy-Wide Measures of Routine and Nonroutine Task Input, 1960–2002



Source: Updated chart from R. Murnane in a private communication (2010). Based on Autor, D., Levy, F. and Murnane, R. (2001) "The Skill Content of Recent Technological Change: An Empirical Exploration." NBER Working Paper 8337. Boston, MA: National Bureau of Economic Research.

e.g. plumbing

e.g. paperwork

e.g. assembly work



# Personally-delivered vs Impersonally delivered

- “Impersonal services are the ones that can be delivered electronically from afar with little or no degradation of quality (e.g., keyboard data entry, manuscript editing).

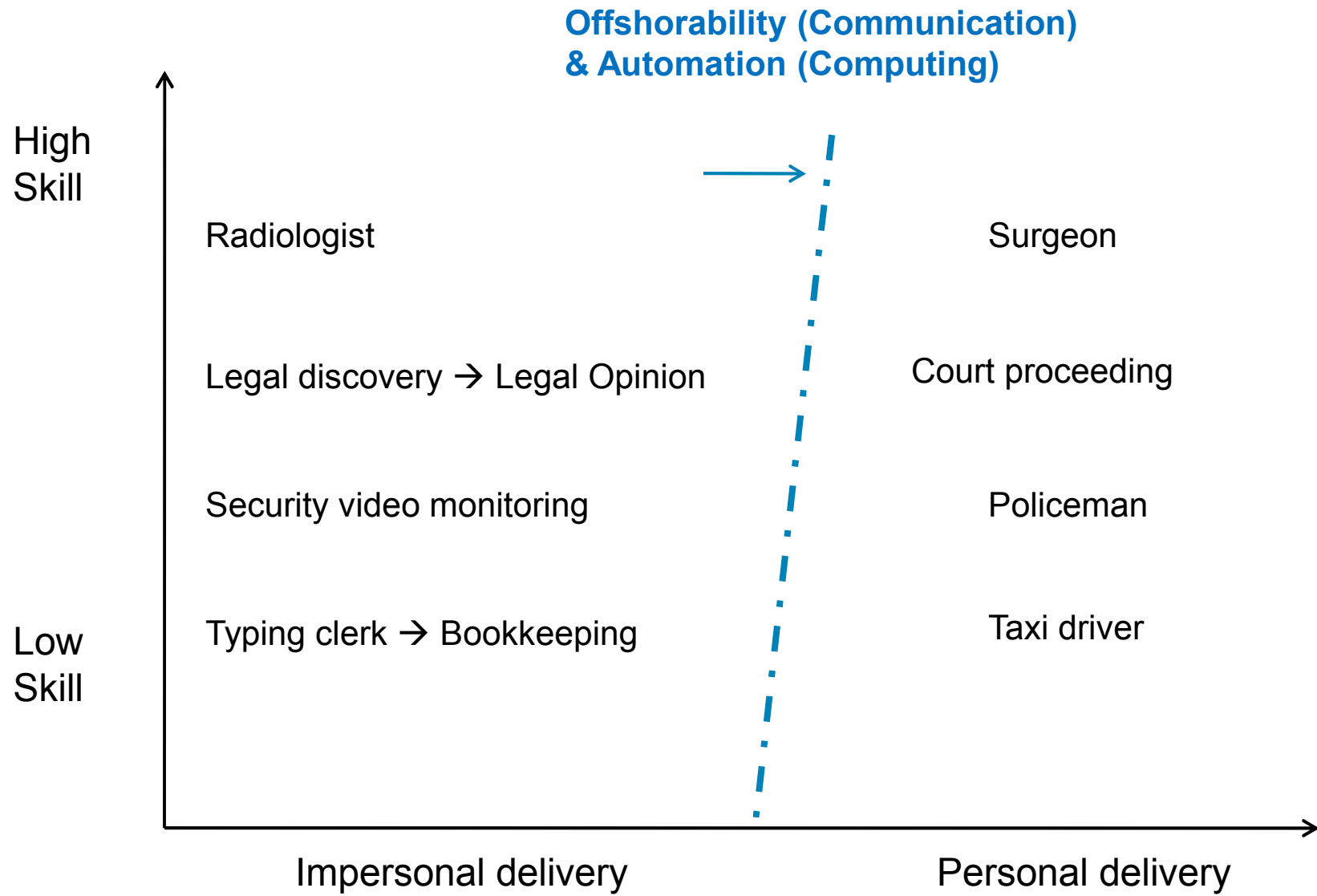
They are potentially offshorable.

- *Personal services* are the ones that either cannot be delivered electronically (e.g., child care) that suffer severe degradation of quality when so delivered (e.g., surgery).

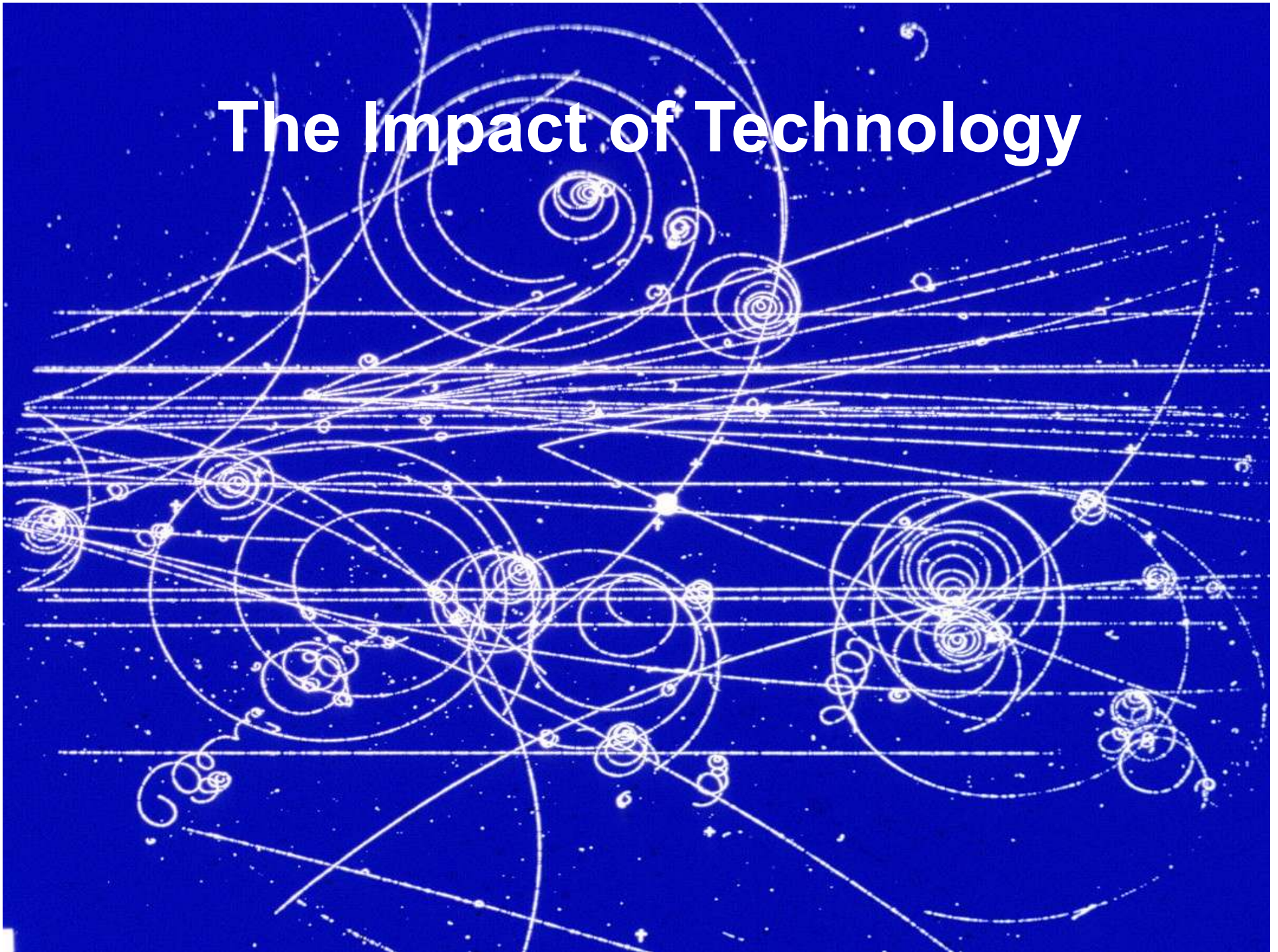
They are, for all practical purposes, non-[offshorable].”

Alan Blinder, Economist, Princeton U., 2006

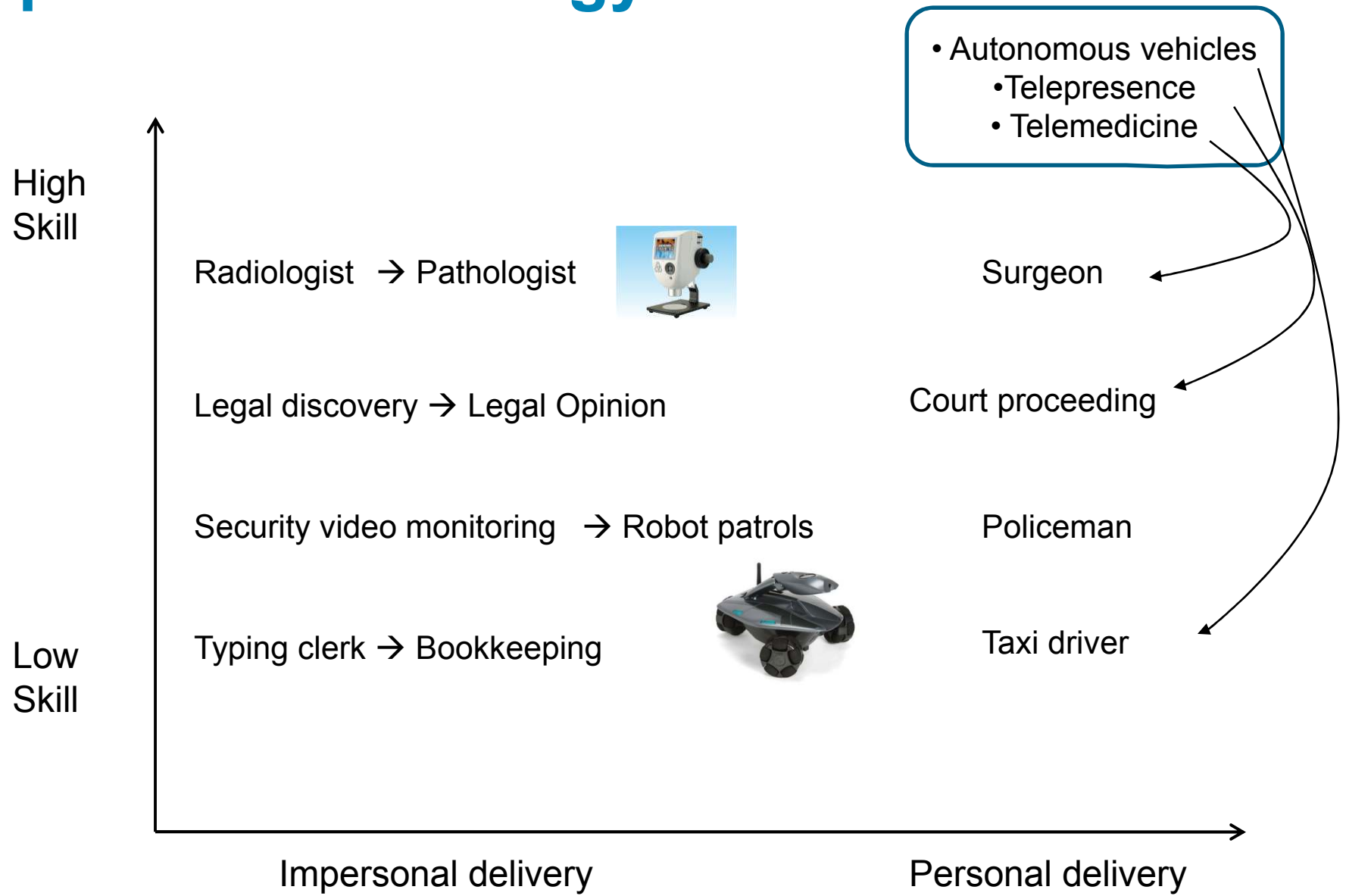
# Skill vs Delivery



# The Impact of Technology



# Impact of Technology



# Displacement due to Technology

Ox → Harvester

Horse → Automobile

Lab Mice → Assays (not soon enough...)

Humans:

Scribes → printing press

Washers → washing machine


Cashiers/Attendants → bar code scanner

Healthcare/Finance/Services/Jeopardy champions → Watson

etc



New Threshold



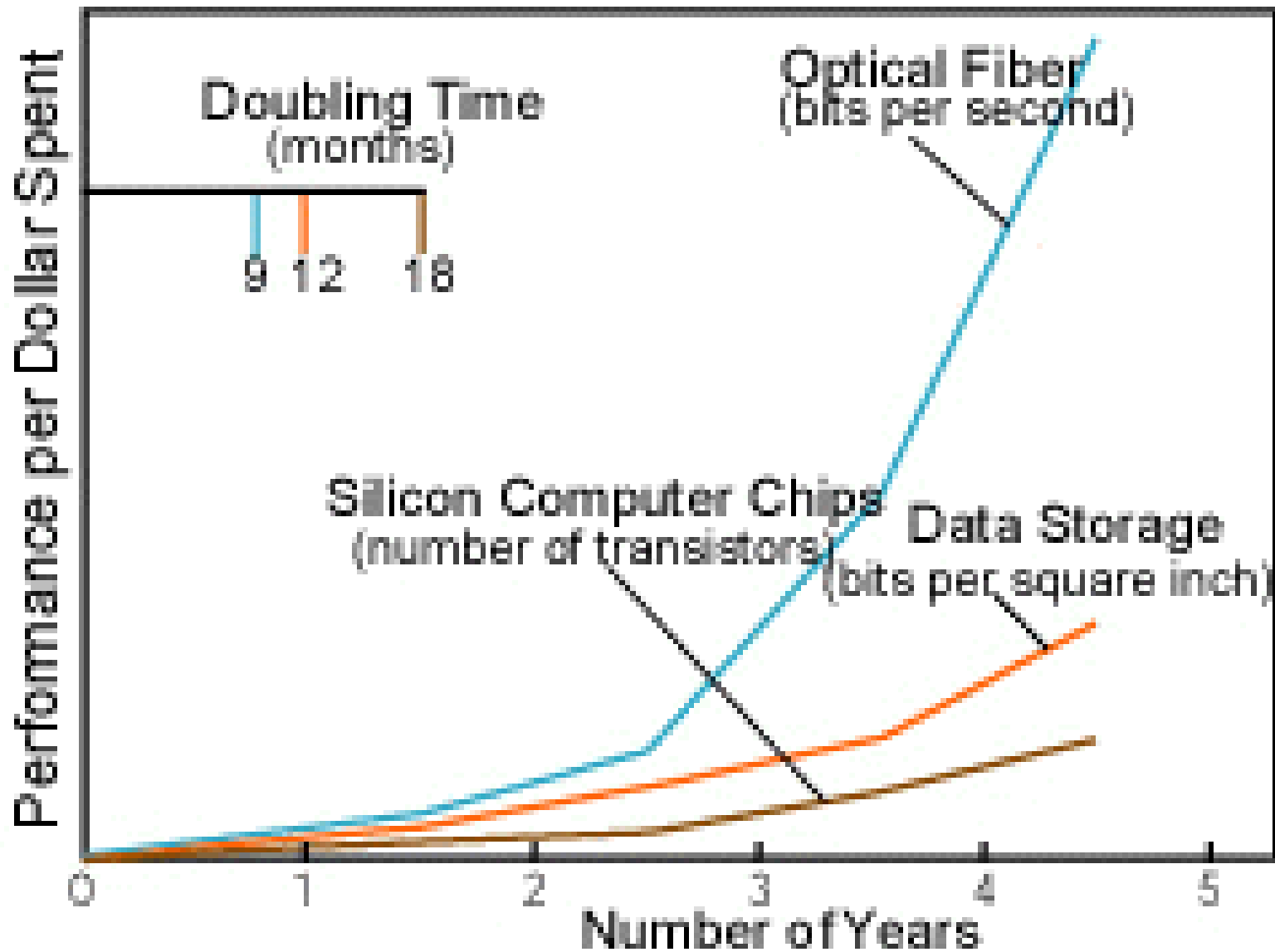
“...in medical education we’re still a very  
memory-based curriculum... Watson-like tools  
will cause us to reconsider what students do”

Dr Herbert Chase

Columbia University

New York Times, Feb. 17, 2011

# Technology *Acceleration*



# Brave New World

Human Genome mapping (2005)

“Technology today can do in five minutes a decoding task that would have taken a year to complete a decade ago”

Eric Lander, Founder, The Broad Institute

*Average improvement  
factor of 10,512 per year !*





# And more to come

- Video record your entire life (2025)
- Brain-in-computer (2030)

“We are currently preparing students for jobs and technologies that don’t yet exist... in order to solve problems that we don’t even know are problems yet.”

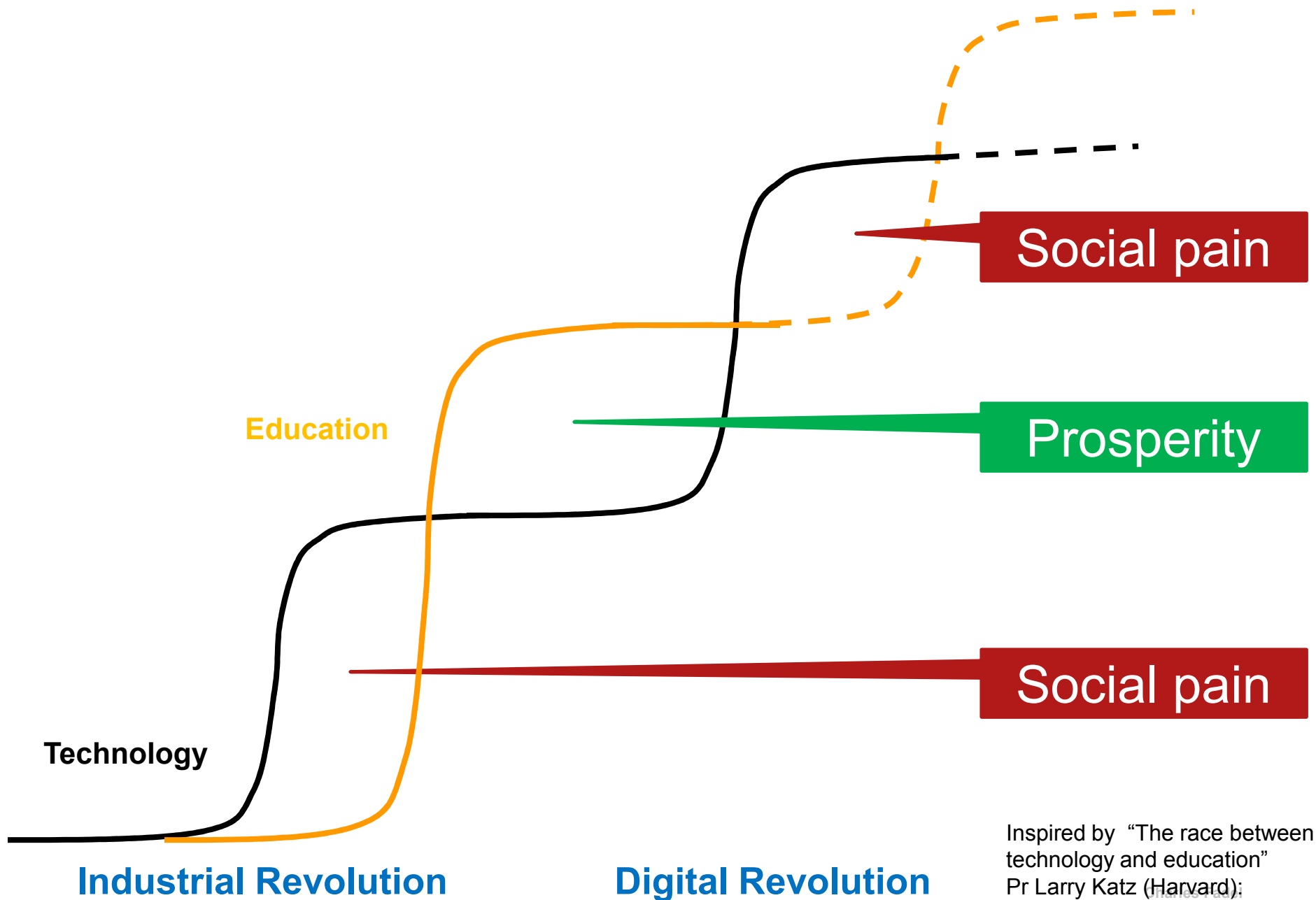
Richard Riley

Former U.S. Secretary of Education

# Other displacement technologies



# The Race between Technology and Education



Inspired by "The race between technology and education"  
Pr Larry Katz (Harvard);

# Change is Inevitable

But do we want a  
Dickensian world ??



# So what do we teach for...

...in an era of ubiquitous “Watsons” that give us answers ?

Possibly:

- *Fluidity* with Technology
- Better Engineering
- Asking the right *questions*
- *Synthesizing/integrating*
- *Creating !*

# The OECD's View

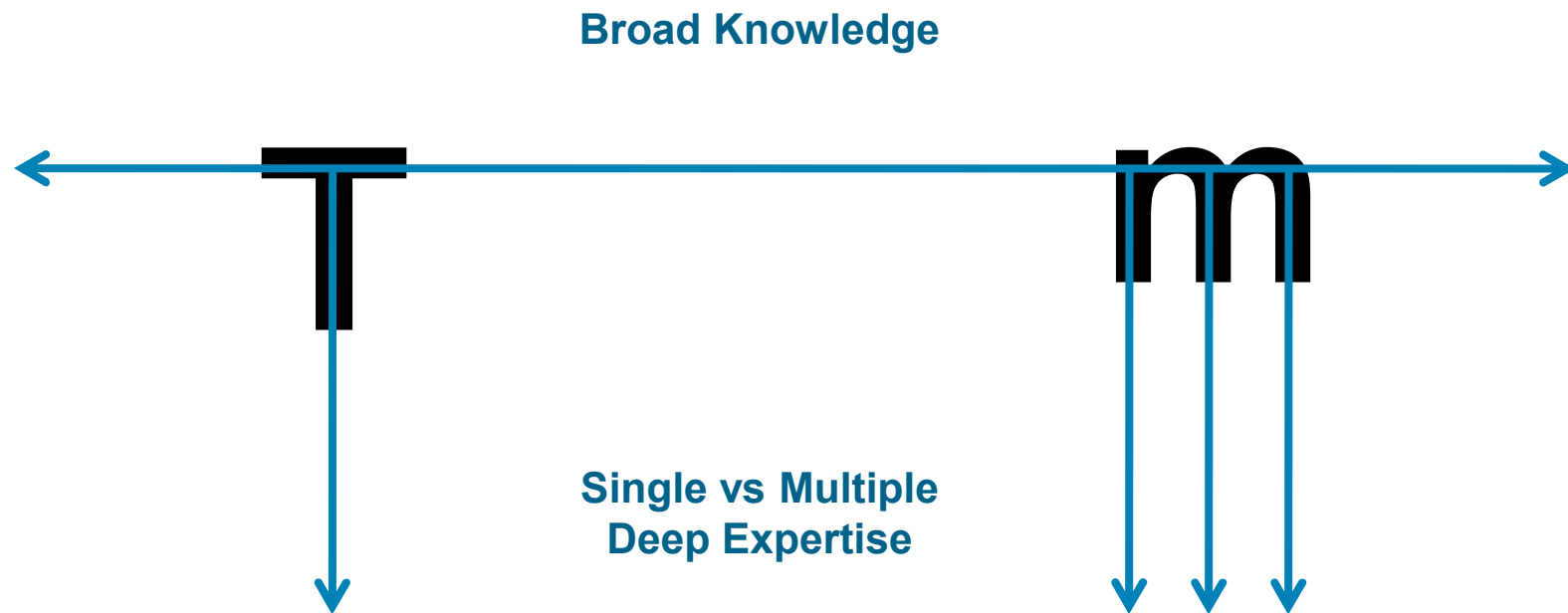
1. The great collaborators and orchestrators
2. The great synthesizers
3. The great explainers
4. The great versatilists
5. The great personalizers
6. The great localizers
  
7. *To which I add:* The great innovators



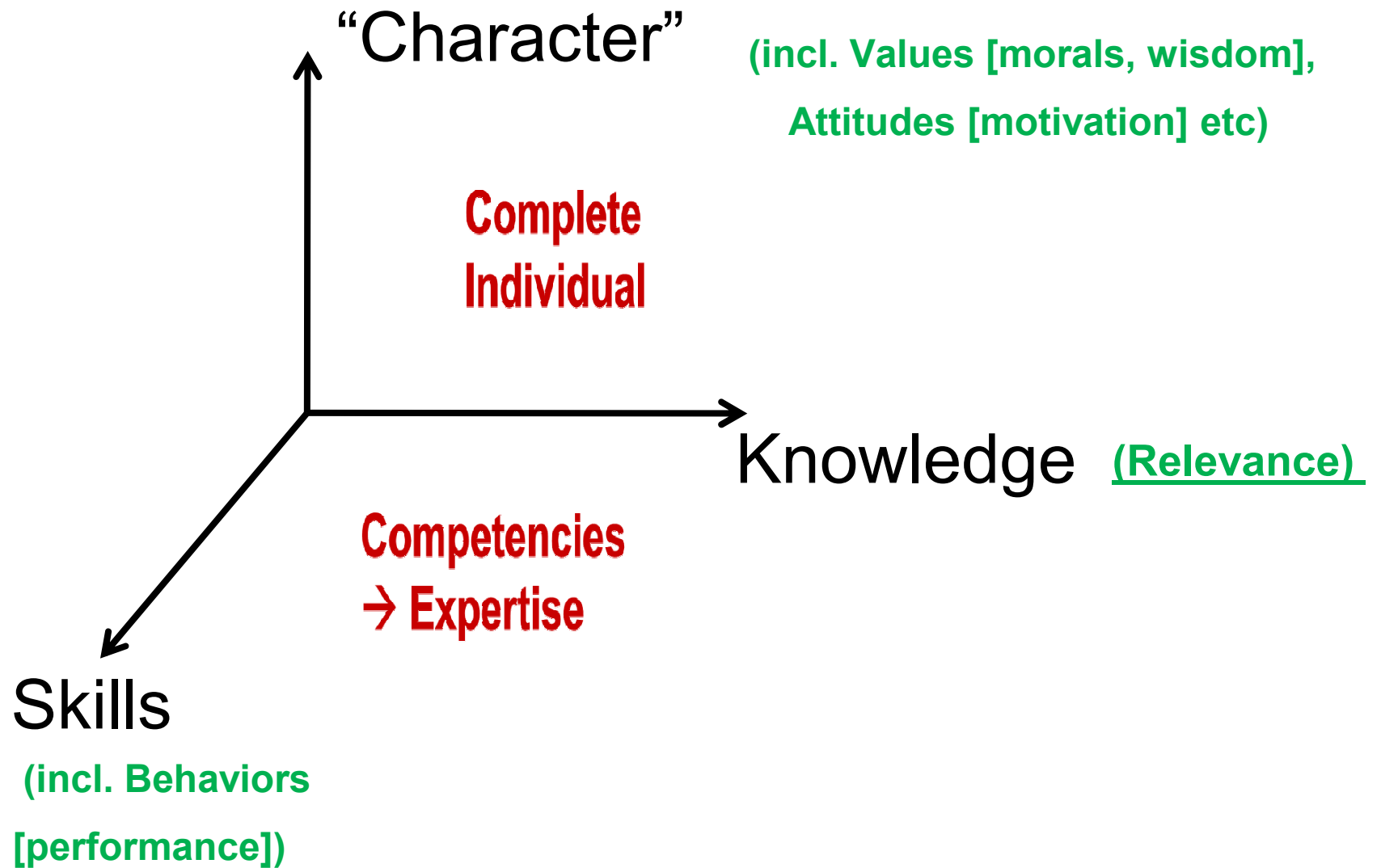
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Source: Andreas Schleicher

# m-shaped Individual, not just T-shaped



# Rethinking What is Taught

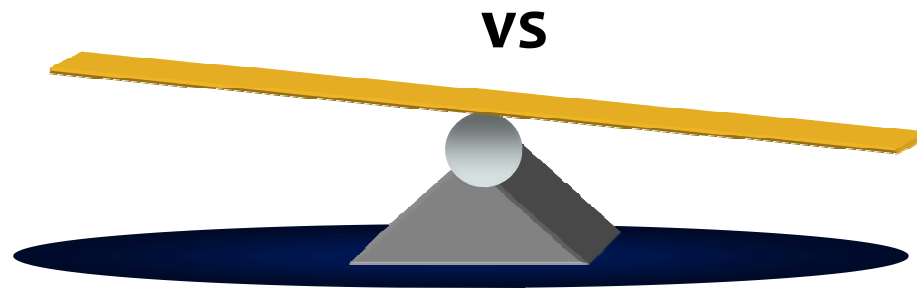






# Age-Old Debate

**Practical  
Subjects**



**Theoretical  
Subjects**

Economic argument vs Psychosocial argument

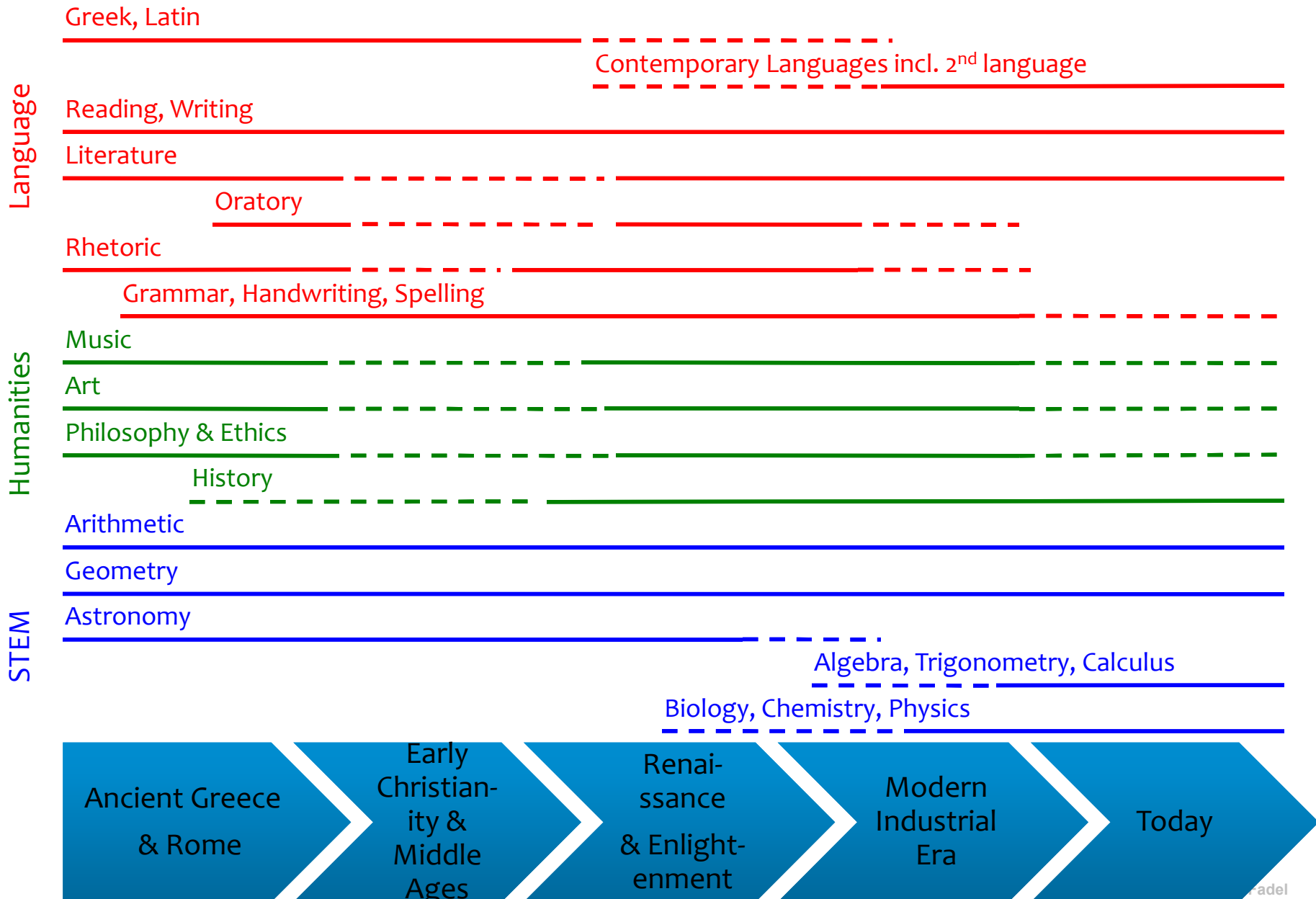
# Schooling vs Real-World

“...school learning is abstract, theoretical and organized by disciplines while work is concrete, specific to the task, and organized by problems and projects...”

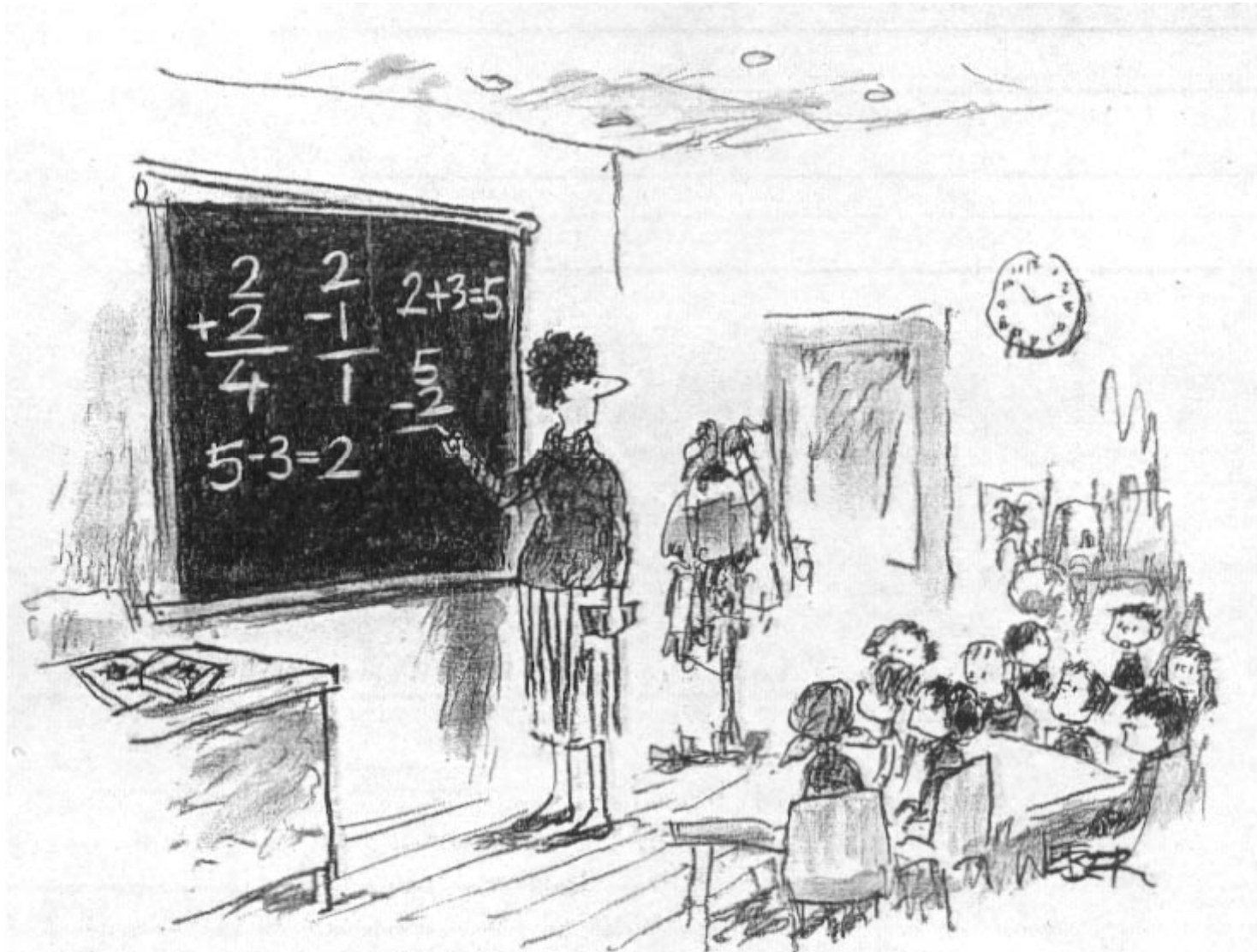
Source: OECD, “Learning for Jobs” 2009

# Subject Evolution

Source: research by UPenn GSE for Cisco



# Begging for Relevance



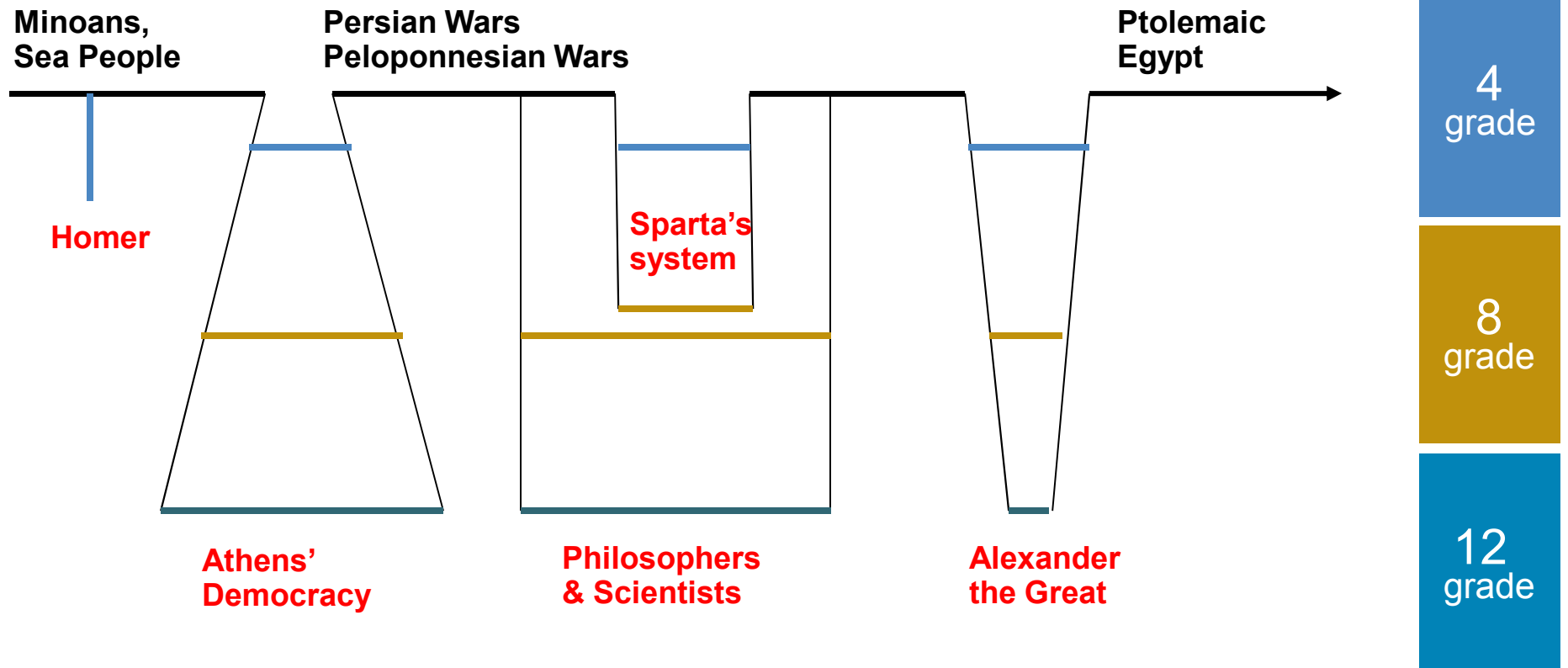
*"Please, Ms. Sweeney, may I ask where you're going with all this?"*

# Relevance is a choice

Discipline (below)	Algebra	Applied Maths	Calculus	Discrete Mathematics	Foundations	Geometry	Numbers & Operations	Statistics & Probability	Topology & Recreational
X represents significant usage in	Matrices, Operations, Vectors etc	Complex systems, Control, Game theory, etc	Analysis, Transforms, Polynomials, etc	Automata, Graphs, Computational maths etc	Sets, Logic etc	Curves, Dimensions, Transformations, Trigonometry, etc	Arithmetic operations, Fractions, Sequences, etc	Distributions, Analysis, Estimation, etc	Knots, Figures, Folding, Spaces, etc
Anthropology							X	X	
Architecture		X				X	X	X	X
Art/Design						X	X		X
Biology (genetics, zoology, etc)	X	X	X	X		X	X	X	X
Business	X	X	X	X			X	X	
Civil engineering	X	X	X	X		X	X	X	X
Computer science	X	X	X	X	X	X	X	X	X
Economics	X	X	X	X		X	X	X	X
Electrical engineering	X	X	X	X		X	X	X	
Geology/Geography	X		X				X	X	
History							X	X	
Law							X	X	
Linguistics		X					X	X	
Mechanical engineering	X	X	X	X		X	X	X	X
Medicine/Pharmacy		X					X	X	
Music			X				X		
Neuroscience	X	X	X	X		X	X	X	
Philosophy					X		X	X	
Physics	X	X	X	X	X	X	X	X	X
Psychology	X	X	X	X			X	X	
Sociology							X	X	

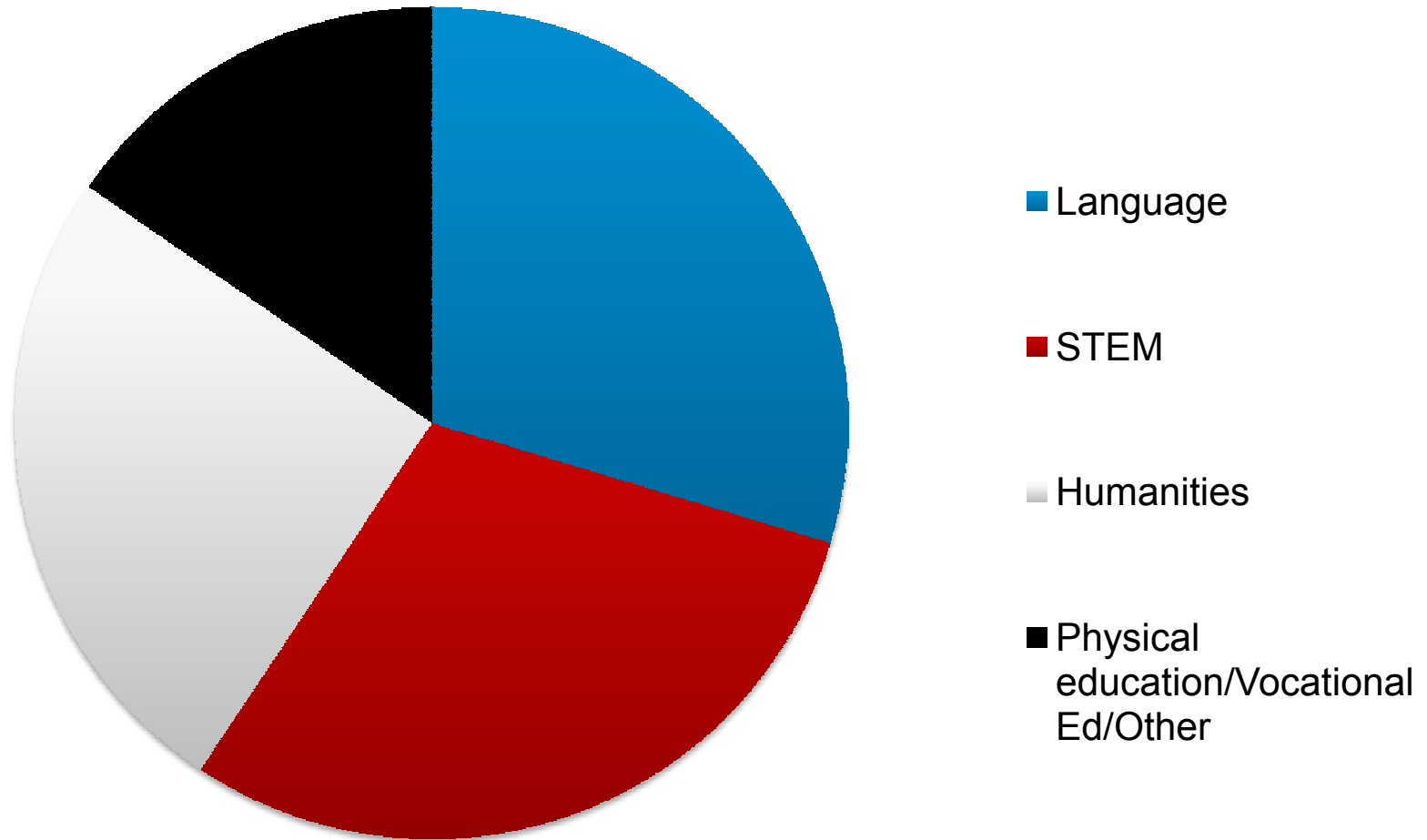
*“Numbers and probability provide the basis for statistics, which, together with Logic, constitute the foundation of the Scientific Method”*  
 John Allen Paulos

# Impact vs Context



Example: Ancient Greece

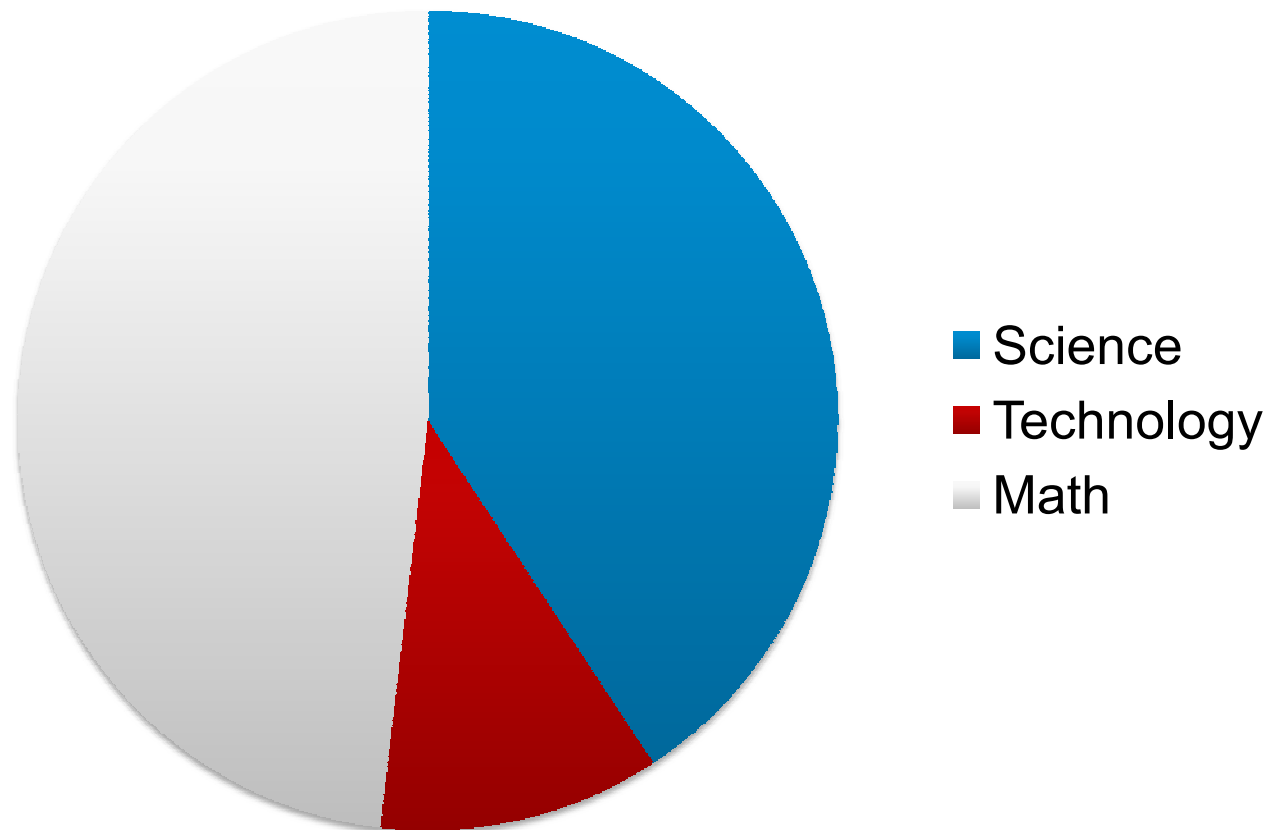
# Ratio of Subjects – OECD Average



What should be the ratios ?



# STEM Education – OECD average



Why so little Technology ? (and so much about volcanoes?)  
Why is Engineering only a College discipline?

# STEM Professions Have a Positive Impact on Innovation Economies

“Our evidence shows that countries with a higher concentration of engineering college majors grow faster, whereas countries with a higher proportion of law concentrators grow slower.”

“If an extra 10% of enrollment was engineering, the growth rate would rise 0.5% per year; if an extra 10% enrollment were in law, growth would fall by 0.3% per year”.

Source: “Allocation of Talent, Implications for growth”  
1990 National Bureau of Economic Research, Murphy et al

# Top 10 Breakthroughs

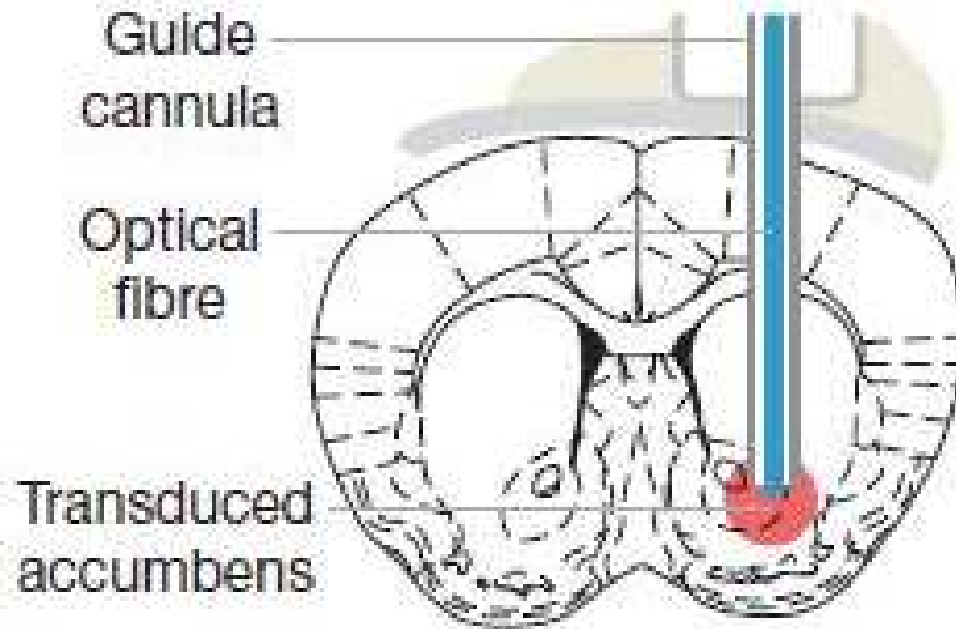
## Transforming Life over the next 20-30 years

1. Alternative energy
2. Desalination of water
3. Precision farming
4. Biometrics
5. Quantum computers
6. Entertainment on demand
7. Global access
8. ***Virtual education***
9. Nanotechnology
10. Smart Robots

Source: World Future Society

# Who would have thought of ...

- 15 years ago: Bioinformatics
- 5 years ago: Optogenetics



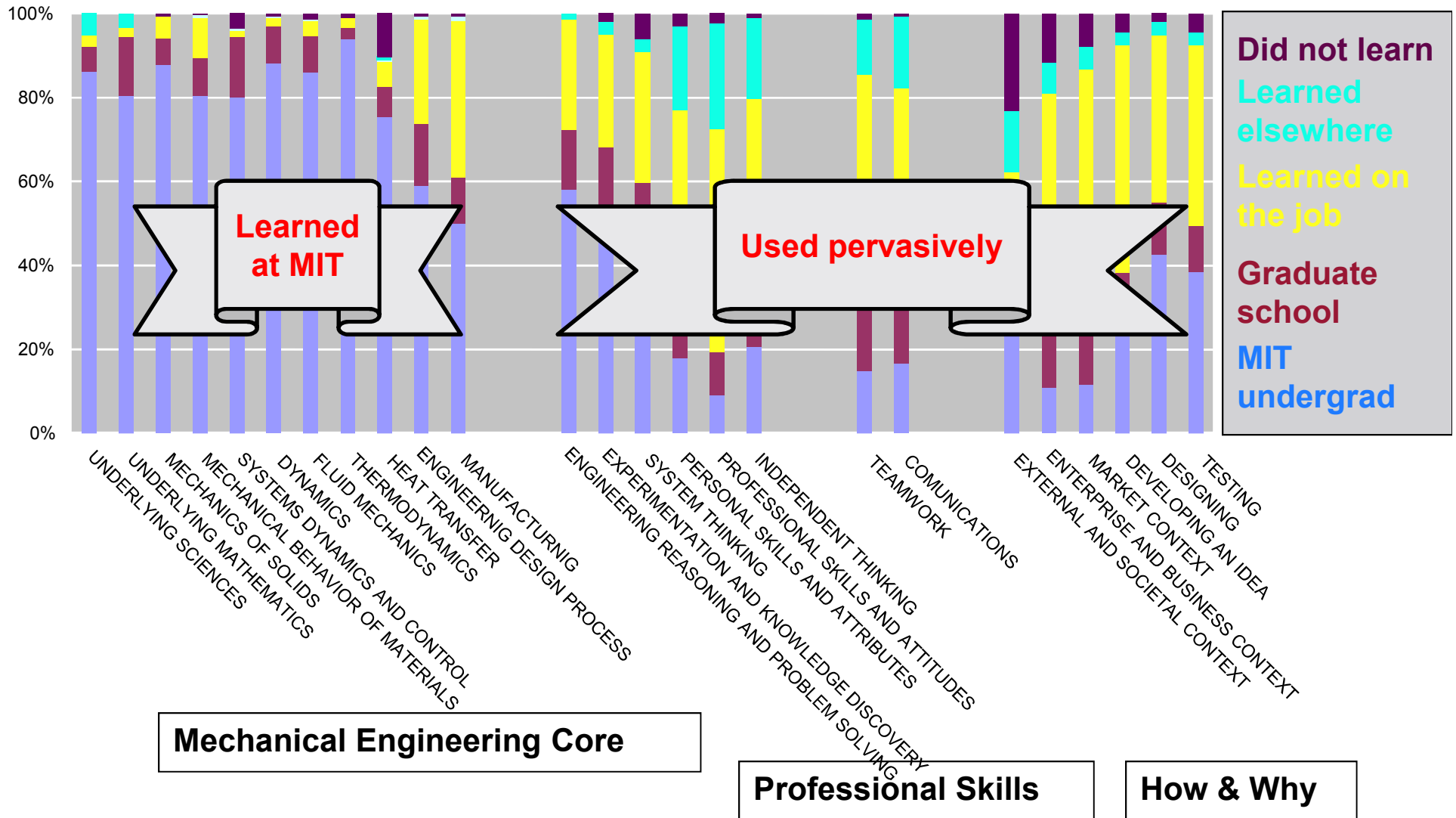
# STEM *AND* Humanities

“STEM for  
Employability...  
...Humanities for  
Excellence”

# Rethinking Skills

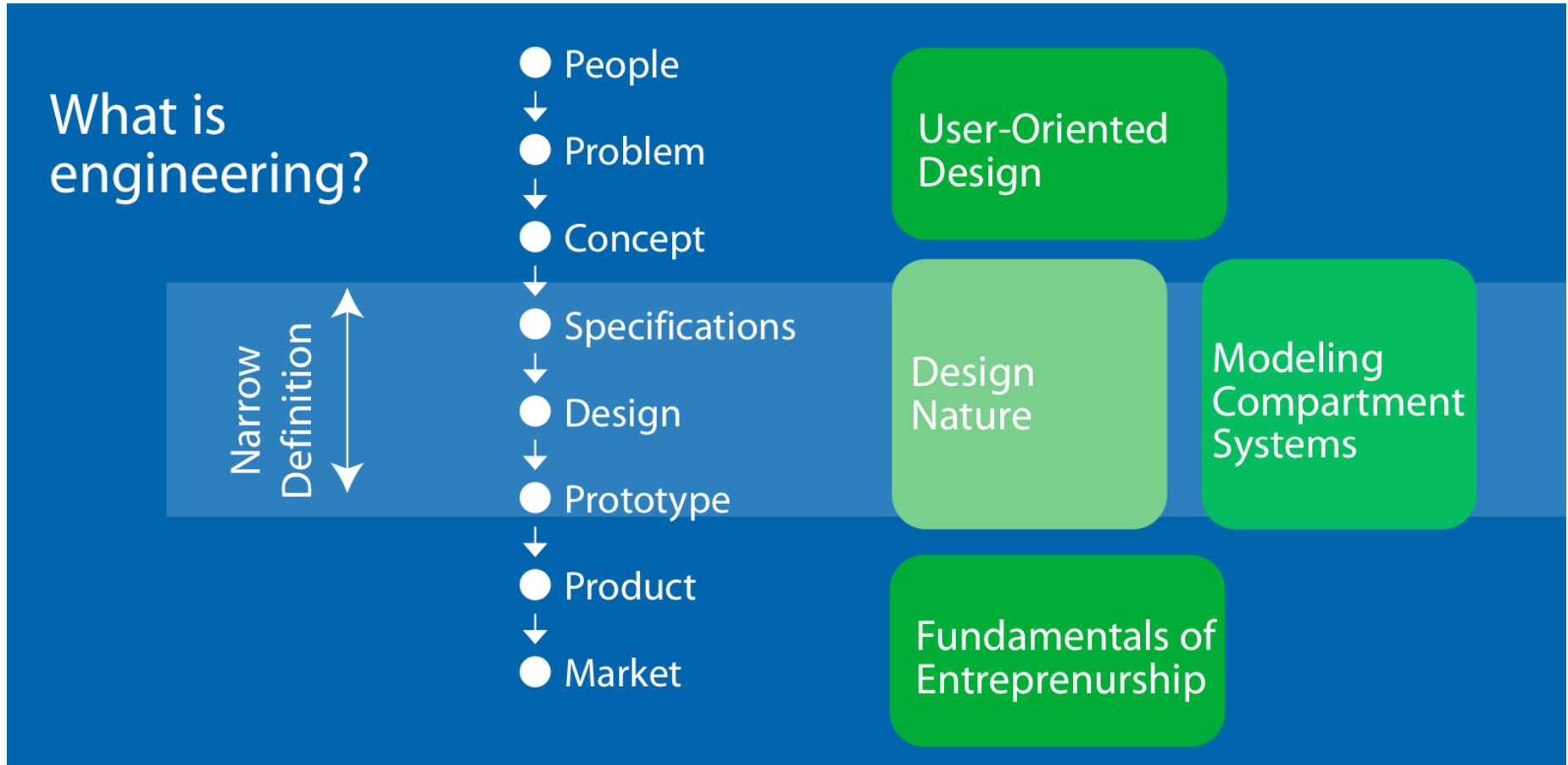


# Mechanical Engineering



Source: Kristen Wolfe June, 2004 S.B. Thesis & Professor Warren Seering. Courtesy Professor Woodie Flowers

# Expanding the Mindset



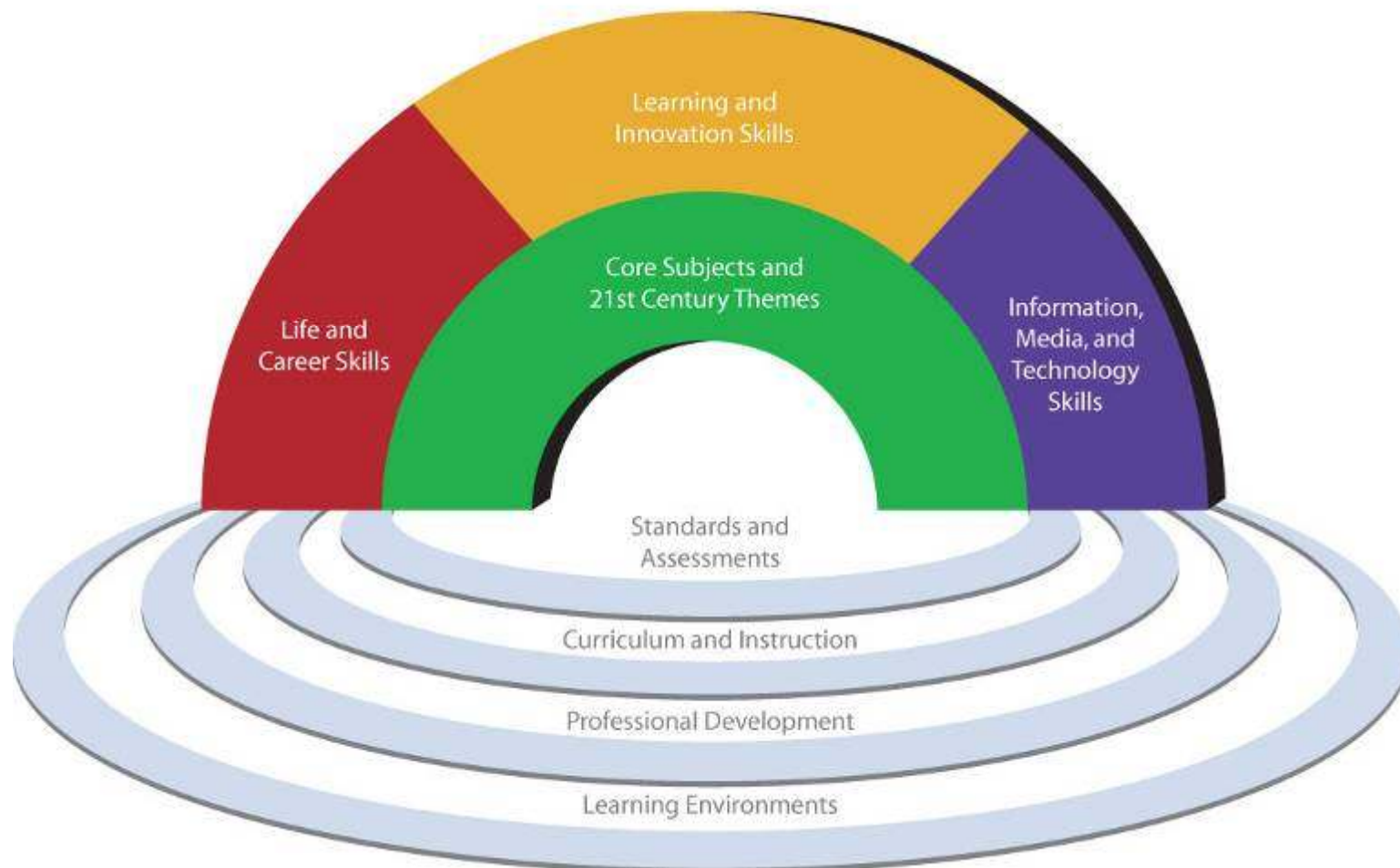
Franklin W. Olin  
College of Engineering

Courtesy of Olin President Richard Miller

Charles Fadel



## 21st Century Student Outcomes and Support Systems



# 21<sup>st</sup> Century Skills Framework

## Learning & Innovation Skills

- Critical Thinking & Problem Solving
- Creativity & Innovation
- Communication & Collaboration

## Information, Media & Technology Skills

- Information Literacy
- Media Literacy
- ICT (Information, Communications & Technology) Literacy

## Life & Career Skills

- Flexibility & Adaptability
- Initiative & Self-Direction
- Social & Cross-Cultural Skills
- Productivity & Accountability
- Leadership & Responsibility

## Practical book + DVD classroom examples

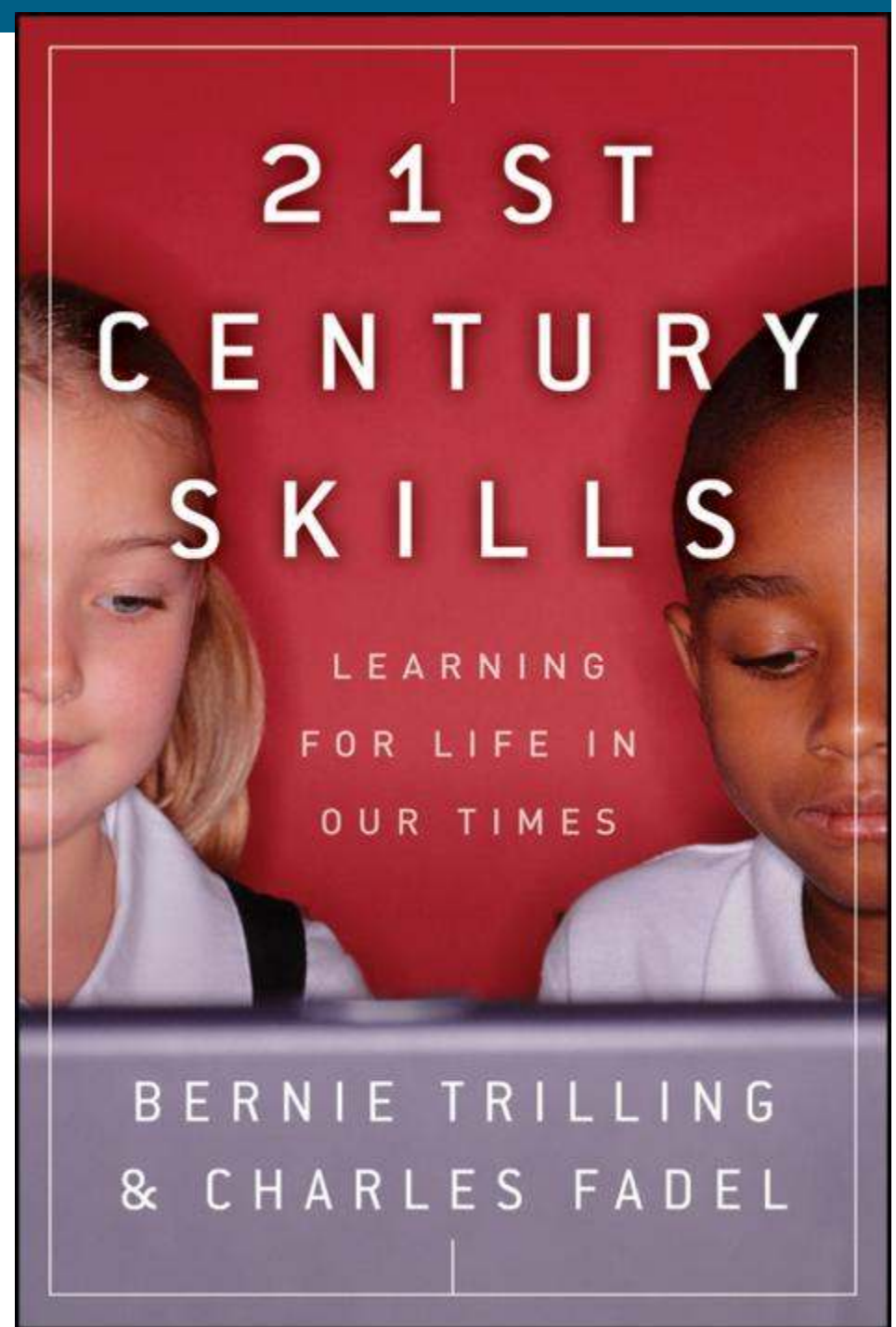
“The authors have done nothing less than provide a bold framework for designing a 21st century approach to education, an approach aimed at preparing all of our children to successfully meet the challenges of this brave, new world.”

Paul Reville, Secretary of Education,  
**Commonwealth of Massachusetts;**  
former director of the Education Policy and  
Management Program,  
**Harvard Graduate School of Education**

“It’s about time that we have such an accessible and wise book about the 21st century skills that so many companies, policymakers, and educators are talking about”

Roy Pea, Professor,  
Education and the Learning Sciences,  
**Stanford University**

<http://www.21stcenturyskillsbook.com>



# Ancient Wisdom

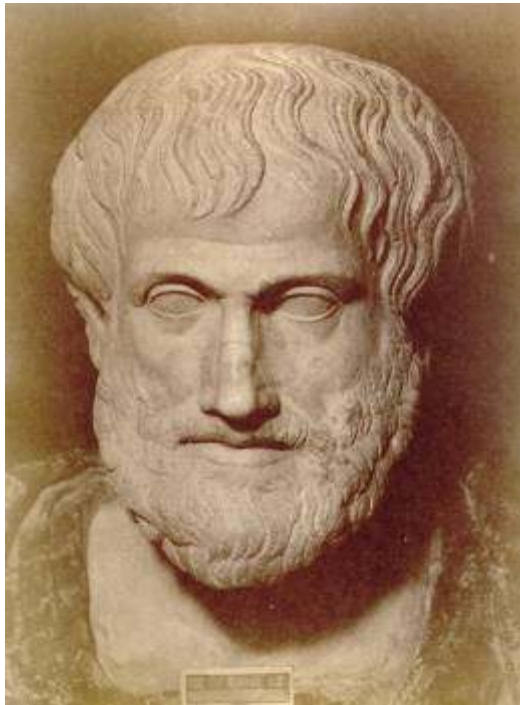


Confucius (551-479 BC):

“I hear and I forget, I see and I remember, *I do and I understand*”

Aristotle (384-322 BC):

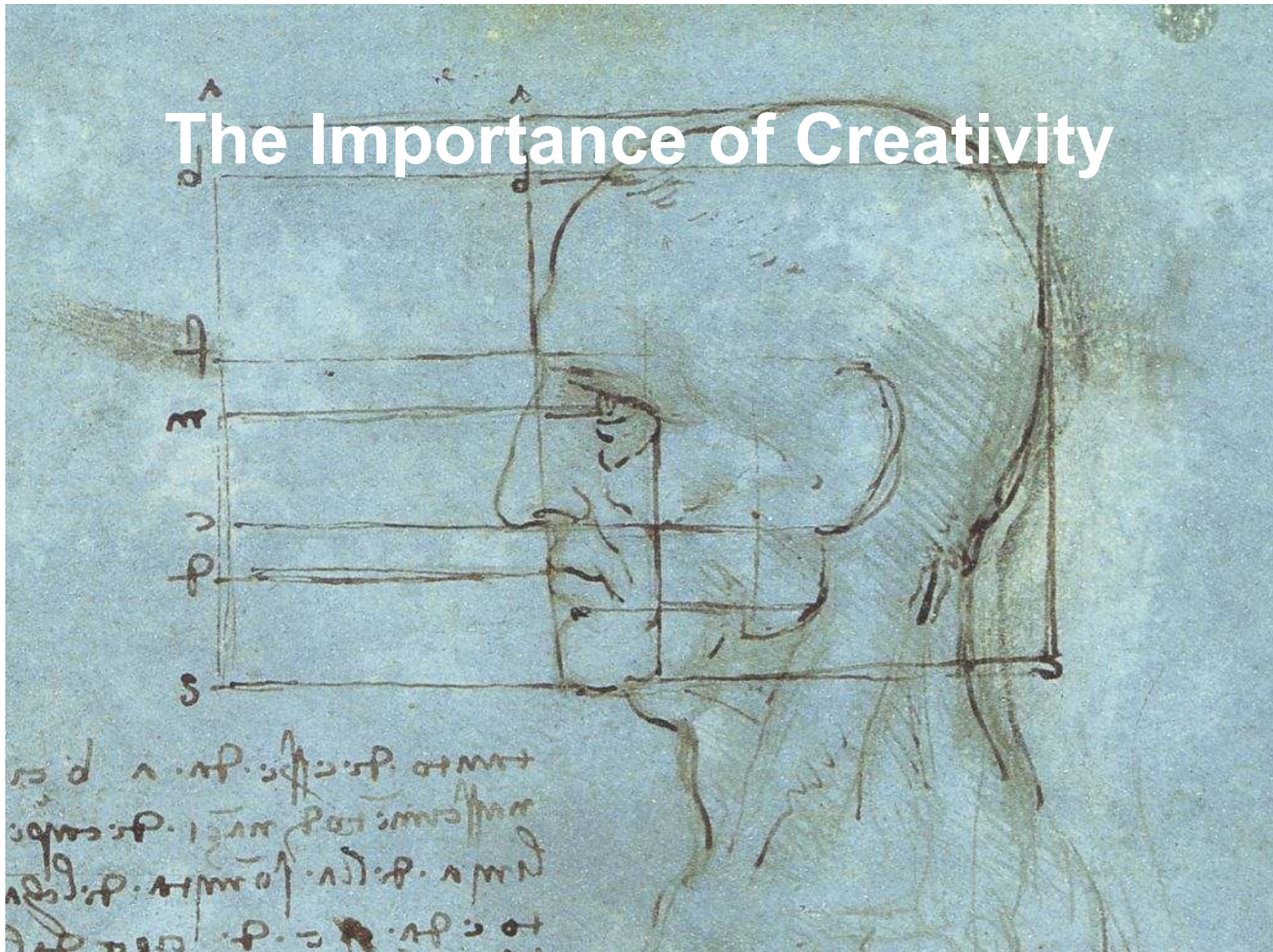
“The proof that one knows something is that *they can teach it*”



Michel de Montaigne (1533-1592 AD):

“rather a mind shaped than a head full”

# The Importance of Creativity



# IN MORE DEVELOPED COUNTRIES

Source: "Tough Choices or Tough Times" 2007, National center on education and the economy

Creative  
Work

- Research
- Development
- Design
- Marketing and Sales
- Global Supply Chain Management

Routine  
Work

DONE BY  
PEOPLE

Routine  
Work

DONE BY  
MACHINES

*Race up the Value Chain*

# IN LESS DEVELOPED COUNTRIES

# Engineering PhD median salary



**US (CA): \$125,200**



**Germany: \$99,400**



**China: \$53,700**



**India: \$39,200**

How do you justify 2-3x differential?

# 21<sup>st</sup> Century Innovation

**iPod = 299\$ of  
Chinese exports  
to US, but...**



## **Distribution of the value added**

- 299 US\$
  - 75\$ **profit** to US (Apple)
  - 73\$ **wholesale/retail** US (Apple)
  - 75\$ to Japan (Toshiba)
  - 60\$ to 400 parts from Asia
  - 15\$ to 16 parts from the US
  - 2\$ assembly in China
- iTunes Music Store (2003)
  - 70% digital market share
  - Big 5 recording companies

**→ Apple garners ~50% of the entire profit of the mobile phone market for 5% of the revenue**



# “Know Thyself” (Oracle of Delphi)

A country’s situation (population size, geography, history, sociology, personality) is its *strength*:

- Japan in 70’s: "Kei-Haku-Tan-Sho" plus "Tei" ("light, thin, short and small" plus "low" cost)

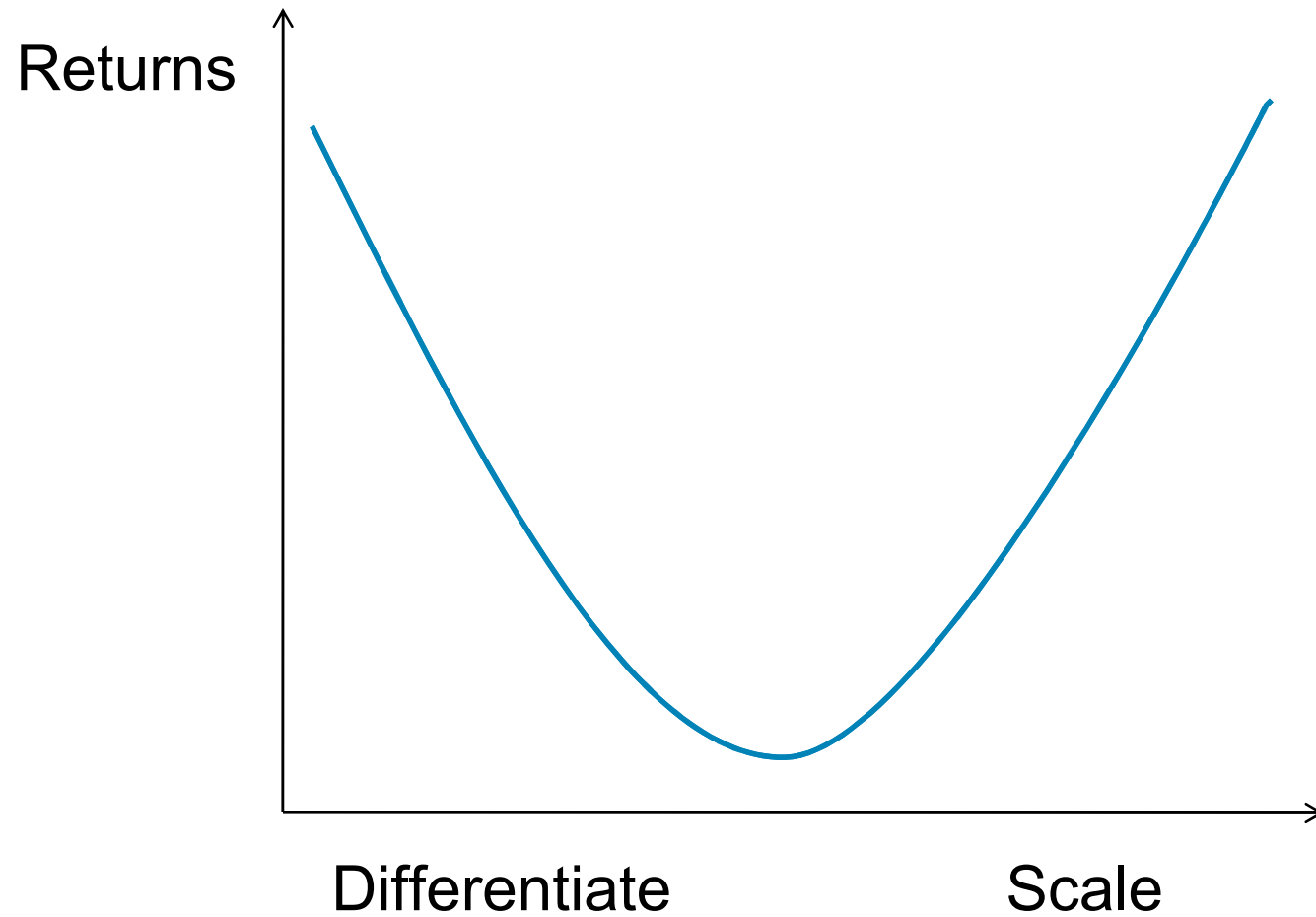


- India now: focused on “poor people’s markets” (\$6 jeans kits; microbanking; village telecenters; \$2k car)



Recommended reads on impact of geography:  
“The Geography of Thought “ - Richard Nisbett  
“Guns, Germs and Steel” - Jared Diamond

# Avoid “Stuck in the Middle”



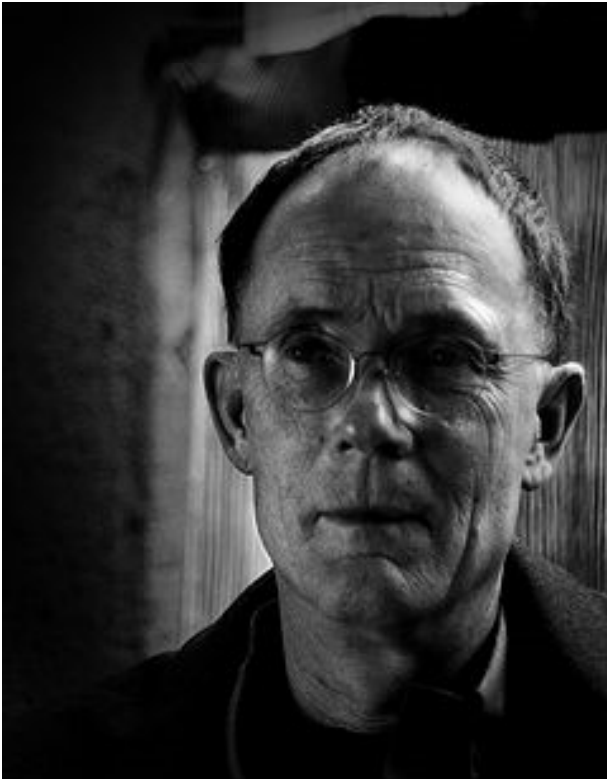
# Reverse Innovation (Vijay Govindarajan, Dartmouth)



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**“The future is already here –  
it's just not very evenly distributed.”**

Science-Fiction author William Gibson,  
quoted in [The Economist](#),  
December 4, 2003



mesitack xiexie danku  
pakka kiitos gratias  
spasibo tesekkur danke akujem  
dziekuje multumesc obrigado salamat  
dziakuj blagodarya tak yavada ou dhan aciutakk  
ederim thankyou koszonom dik gamsahabnida arigato  
ash-shkr efcharisto sas nirringrazjak  
merci dekuji dankie paldies grazas  
hvala asante