The future of the mind: the future of ingenuity

Professor Martin Westwell
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science
education
in the 21st century

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Human Ingenuity
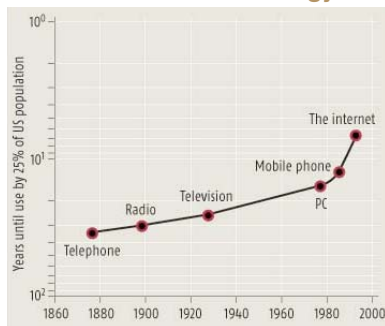## building capacity for life in the 21st century

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What characteristics / skills / capacities acquired / displayed at school lead to social and economic prosperity for young people?

"The future"

Mass use of technology

Years until use by 25% of US population

- Telephone
- Radio
- Television
- PC
- Mobile phone
- The internet

after Kurzweil 2005 *"The singularity is near"*

Predicting the future

At current rates of progress (number of technological inventions) we can expect:

- **over the next 25 years   - 100 years worth of progress**

- **over the next 100 years - 20,000 years worth of progress**

after Kurzweil 2005 *"The singularity is near"*

Predicting the future

"We are preparing our students for jobs that don't exist, using technologies that have not been invented, to solve problems that we haven't even considered yet."
Richard Riley, US Secretary of Education (1999)

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changing thinking

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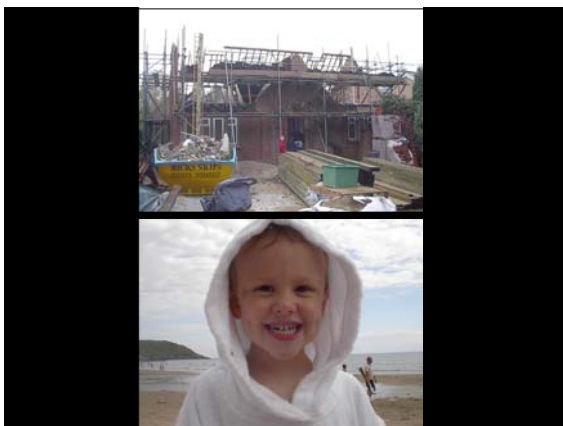*inspiring achievement*

Bits of your brain

What is a mind?

- You are born with almost all your 100 billion neurons

- The growth of connections between cells accounts for the growth of the brain after birth (150 trillion)
- These connections reflect experience

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change the environment - change thinking

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Impact of information technology

information → knowledge

- downloading essays from the internet "could not be controlled"
- "The availability of the internet is a powerful aid to learning but carries a new generation of risks of plagiarism."

QCA chief executive, Ken Boston
(November 2005)

Impact of information technology

Question rich
Answer poor ➡ **Question poor**
Answer rich

Socialisation rather than information has emerged as the primary use of the internet

Online society

175M (15.3M Australian)   13+

facebook

Facebook helps you connect and share with the people in your life.

253M   14+

myspace.com Australia™

67M   13+

orkut

90M   16+

☺**friendster**®

70M   13+

hi5

40M   13+

bebo

#3 USA   306M
#4 Indonesia   230M

Online society

- more social
- reinforce social links
- extrovert
- "happy"

- withdrawn
- break social ties
- isolated
- depressed

Technology

**It's not the technology that changes the way you think
- it's about you and what you do with it**

access to extremes of behaviour

Developing skills

- **Hybrid laparoscopy training system (video & real)**
  21 residents, 12 attending, 15 men, 18 women

- **Past game play (>3hr/week)**
  37% fewer errors (P<0.02)
  27% faster (P<0.03)

- **High scoring gamers (top tertile)**
  47% fewer error (P<0.001)   **39% faster** (P<0.001)

- **Relative weight analysis**
  0.3% years of training   2% sex   2% cases performed
  10% video game experience   31% video game skill

NINTENDO GAMECUBE.

SUPER MONKEY BALL 2

E   SEGA

Rosse et al 2007, *Archives of Surgery*
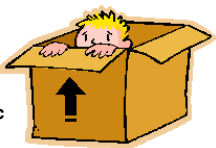
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limitation through categorisation

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Limitation through categorisation

- **IQ tests & planting doubt**
- **Purposeless streaming**
- **Specialist schools**
- **Value of education, literacy, etc**
- **Dad couldn't do that either**
- **Boys vs girls**
- **Visual learners / "preferred learning styles"**
- **Left brain vs right brain**
- **Theory of intelligence**

Limitation through categorisation

- **Theories of intelligence (early adolescents)**

A fixed "thing"	Malleable
- measuring ability	- skill acquisition
- performance goals	- learning goals
- futility of effort	- utility of effort
-setbacks: perservere/withdraw	- setbacks: change strategy
-"intellectual ability fixed"	-"intellectual ability can be developed"

L.S. Blackwell et al *Child Development* (2007) **78** 246-263

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'Brainology'

L.S. Blackwell et al *Child Development* (2007) **78** 246-263
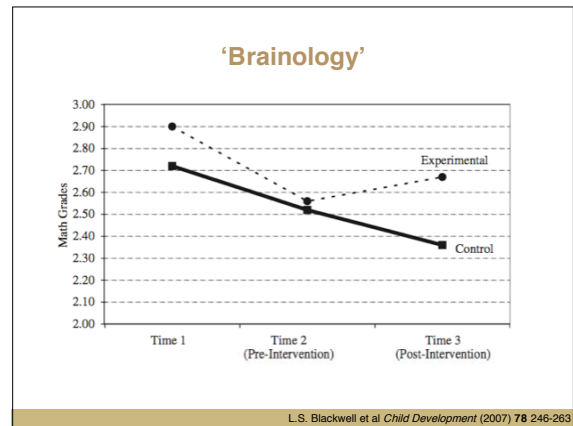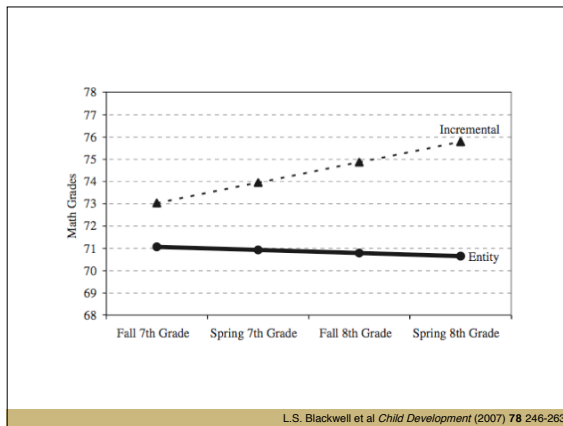
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21st century skills - executive functions

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Manipulating the environment: executive functions

- sustain or appropriately switch attention
- inhibition of responses/impulses
- planning behaviour
- initiation of strategies
- error correction
- switching strategies
- working memory
- coordination – thinking!

concentration

resisting temptation

delayed gratification

self-directed learning

interdependent learning

problem solving

creativity

innovation

Manipulating the environment: executive function

- Aspects of our thinking that relates to how we control our thoughts and actions

- Used in new environments or when you have to do something different to normal - **organise** our thinking and behaviour

Frontal lobes in executive function

Most interconnected region of the brain: all other parts of the brain (sensory, motor, automatic emotions)

Plays coordinating roles:
- integrates diverse representations
- exerts control over systems

Brain development 4 - 21 year old

Last to finish developing

N. Gotay et al *Proceedings of the National Academy of Sciences, USA* (2004) **101** 8174-8179

Two types of mental processes taking place in the brain at the same time:

Controlled (EF)	Automatic
Thinking that takes effort - centre stage	Thinking that happens without conscious control
One at a time	In parallel
Novel responses	Well-rehearsed (routine)
More frontal lobes	All over the brain
e.g. planning a journey	e.g. steering, braking, reading the road

Impossible to keep track of everything - most mental processes happens automatically

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Automatic processing plays a big part in decisions

Executive Functions - The brain's 'bouncer'?

or   ?!

Brain - 'Elephant and rider'

Rider = controlled conscious thinking (EF)

Elephant = automatic processing

Can we help young people develop these critical executive function abilities?

Tools of the Mind - Curriculum

• Core of 40 activities to promote EF and self-regulation

'Buddy reading' - improve attention and listening/self-regulation

Strong emphasis on intentional, make-believe play:
• remembering role (WM),
• inhibit acting out of character
• adjust to the evolving plot (cognitive flexibility)

Slide 1

- **sustaining** and appropriately **switching attention** goal setting
- **planning** (including the modification of plans)
- **prioritising** (including the modification of priorities)
- **devising**, switching and modifying of **strategies**
- **implementation** of **strategies** and plans
- **inhibition** of **responses/impulses** error correcting
- **working memory** (mentally holding/using information)
- **organising behaviour**
- **flexibility** and **adjusting** to change
- **self-regulation**
- **anticipation** and prospective memory (intention to act in the future and to do so appropriately)

Slide 2

Walter Mischel - Classic
'Marshmallow Experiment'
Importance of self-control

frustration
self-esteem
sociability
SAT scores

4-year olds   19-year olds
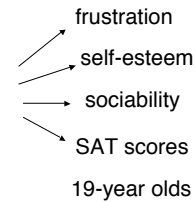
Mischel, W. *et al* (1989). *Science, 244,* 933-938

Slide 3

Predicting the future! (from the past)

People born in 1970:

Age	Factor	%	Type
Aged 10	Mathematics	5.4%	(cog)
Aged 10	Application	4.7%	(none-cog)
Aged 5	Copying	4.2%	(combination?)
Aged 10	Locus of control	3.0%	(non-cog)
Aged 10	Reading	1.3%	(cog)

The non-cognitive factors became 25% more important in determining earnings later in life between 1958 and 1970 cohort while cognitive factors became 20% less important.

Application: the child's concentration and perseverance and his/her ability to understand and complete complex tasks
(Margo & Dixon, 2006)

Locus of control: the degree to which students perceived events to be within their control and their sense of personal agency

Blandon et al. Working Paper no. 06/146, University of Bristol

Slide 4

FREEDOM'S ORPHANS
Raising youth in a changing world

"… as opportunities opened up for [individuals] reaching adolescence between 1960 and 2000, young people's agency became more important in determining their outcomes throughout life, in education, in work and in their communities."

"These developments affected the disadvantaged in particular. Life course events that were once normatively structured by 'traditional' institutions (…clear, if oppressive, career paths), were increasingly left to individuals to decide on their own, leaving them to take on new responsibilities for living with the consequences of their actions.

For those with the capacity to take advantage of these changes, typically the affluent, expanding opportunities led to improved outcomes. But for those without, events left them further behind than ever."

No real support to make decisions or build capacity to decision-make

"Freedom's Orphans" Margo et al, IPPR 2006

Slide 5

Changing environments
Changing world
Changing skills/capacities
Changing understanding

Changing human ingenuity

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Slide 6

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test of attention

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