



# School Leadership in Challenging Contexts

## The need for 21<sup>st</sup> Century Skills

**Nic Spaul** | [www.NicSpaull.com](http://www.NicSpaull.com) | 25 September 2017



Preparing students for jobs that  
don't yet exist





The euro crisis, continued

Thursday 25.07.13  
Published in London and Manchester  
£1.40

**the guardian**  
guardian.co.uk

# A refugee crisis for the world

● Exodus from Syrian civil war is overwhelming region - UN   ● Britain may be asked to take thousands of displaced people   ● Aid officials say population flight is becoming permanent



The Zaatari refugee camp near the Jordanian city of Mafraq shelters 15,000 Syrian refugees, posing a humanitarian crisis and a threat to global security, say UN officials

## Arctic stronghold of world's seed bank flooded after permafrost melts

No seeds were lost but the ability of the rock vault to provide against all disasters is now threatened by climate change



① The Svalbard 'doomsday' seed vault. Photograph: Joe

### as Florida evacuates

Category five superstorm hits Turkey and Caicos Islands, with at least 13 people confirmed dead across Caribbean

'Like a horror movie' / Survivors tell

"All the News That's Fit to Print"

**The New York Times**

VOL. CLXV . . . No. 57,050   © 2015 The New York Times   SATURDAY, NOVEMBER 14, 2015

## PARIS TERRORIST ATTACKS KILL OVER 100 FRANCE DECLARES STATE OF EMERGENCY

**Bursts of Chaos and Horror, Once Again**

By LIZ ALDERMAN and JEN VANDUEY

PARIS — The night was chilly but thick with excitement as the big match between France's national soccer team and archrival Germany was underway at the national stadium in a northern suburb of Paris. President François Hollande watched with the crowd as the French players pushed the ball across midfield. Then came the shattering, unmistakable crack of an explosion, overwhelming the roar of the crowd. A stunned moment passed. Players and spectators moved northward and southward.

**Series of Shootings Apparently**

By ADAM NOSSEITZ

PARIS — The Paris area reeled Friday night from a bloody rampage, explosions and mass hostage-taking that President François Hollande called an unprecedented terrorist attack in France. His government announced sharply increased border controls and heightened police powers as it mobilized its military in a national emergency. French television and news services quoted the police as saying that around 100 people had been killed at a concert site where hostages had been held during a two-hour standoff with the police, and that perhaps do



BBC Sign in News

## NEWS

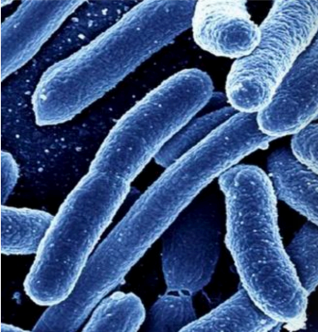
Home Video World UK Business Tech

### Health

## Superbugs to kill 'most' 2050

Fergus Walsh  
Medical correspondent

11 December 2014 | Health




Drug resistant E.coli bacteria are already a significant

### Analysis: Antibiotics

By James Gallagher  
Health editor, BBC News website

19 November 2015 | Health



Some bacteria are becoming resistant to our best drugs

the guardian

news / opinion / sport / arts / life

world / europe / US / americas / asia / australia / middle east / africa / more

### Nato

## Nato chief: world is at its most dangerous point in a generation

Exclusive: Jens Stoltenberg warns of converging threats as Russia mobilises estimated 100,000 troops on EU's borders



Secretary general Jens Stoltenberg visits Nato battle group soldiers at

Photograph: Raigo Pajula/AFP/Getty Images

f t e ...

Daniel Boffey in Tapa

Friday 8 September 2017 18.00 BST

f t e ... Share

stability threat'

Madman heralds a grave new world

**AUSTRALIAN**

SCIENTIFIC AMERICAN

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POLICY & ETHICS

## Will Democracy Survive Big Data and Artificial Intelligence?

We are in the middle of a technological upheaval that will transform the way society is organized. We must make the right decisions now

By Dirk Helbing, Bruno S. Frey, Gerd Gigerenzer, Ernst Hafen, Michael Hagner, Yvonne Hofstetter, Jeroen van den Hoven, Roberto V. Zicari, Andrej Zwitter on February 25, 2017





## Software Sabotage

How Stuxnet disrupted Iran's uranium enrichment program

**1** The malicious computer worm probably entered the computer system – which is normally cut off from the outside world – at the uranium enrichment facility in Natanz via a removable USB memory stick.

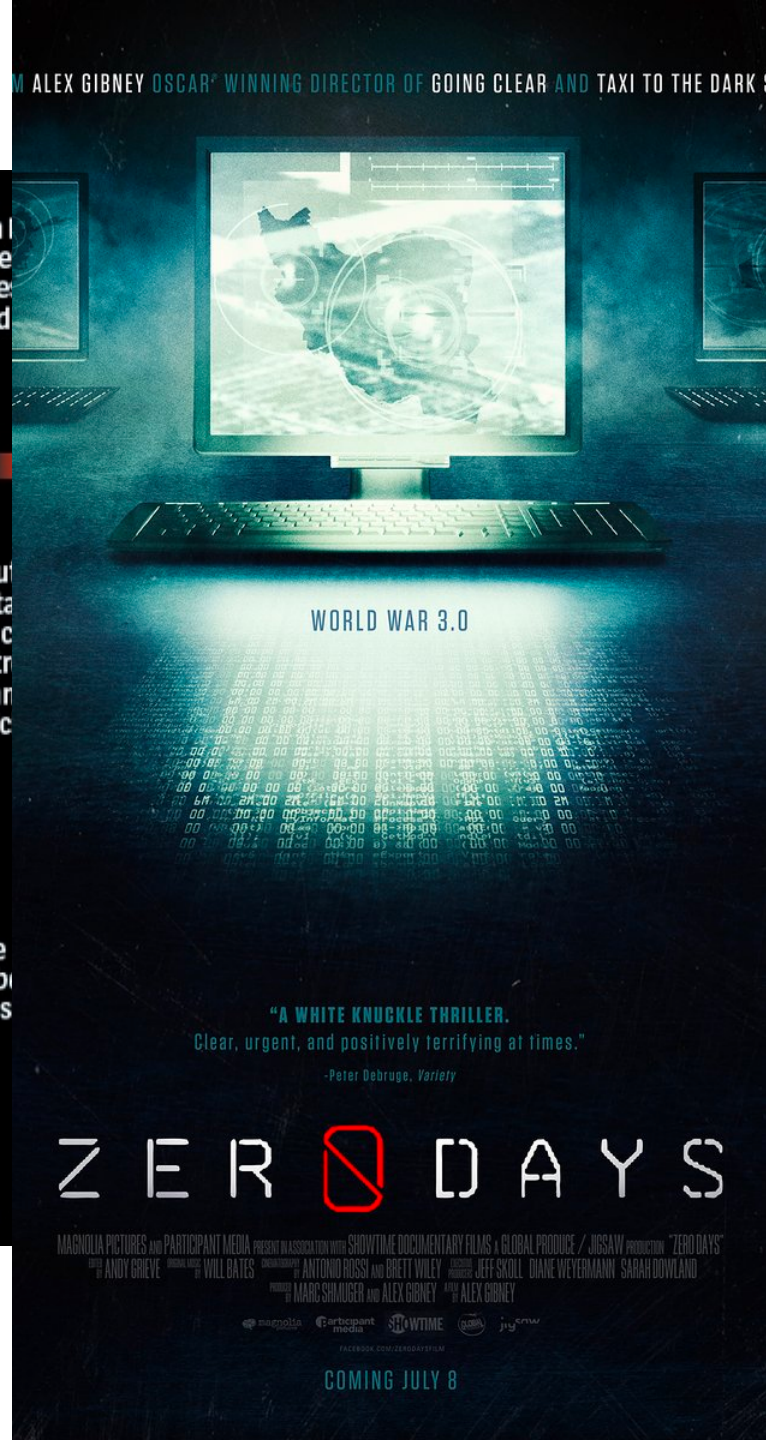
**2** The virus is controlled from servers in Iran and Malaysia with the help of two Internet addresses, both registered to false names. It infects some 100,000 computers around the world.

**3** Stuxnet spreads through the system until it finds computers running the Siemens control software. Step 7, which is responsible for regulating the rotational speed of the centrifuges.

**4** The computer varies the rotational speed of the centrifuges. This can destroy the centrifuges and the uranium enrichment program.

**5** The Stuxnet attacks start in June 2009. From this point on, the number of inoperative centrifuges increases sharply.

Source: IAEA, ISIS, FAS, World Nuclear Association, FT research



# Stuxnet Virus





Our World  
in Data

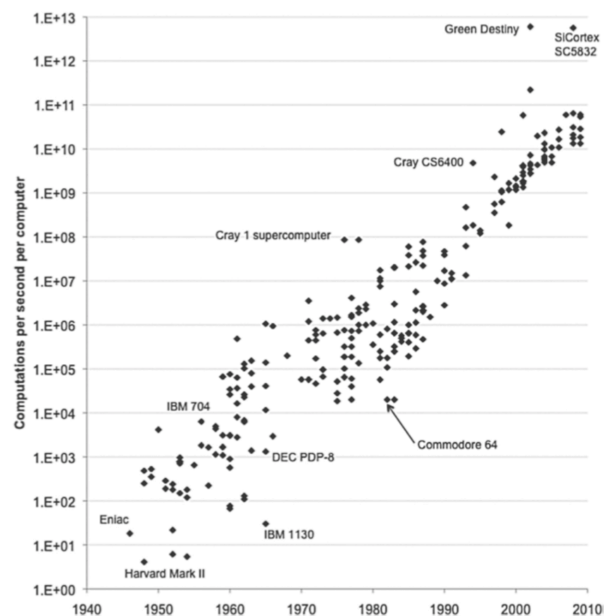
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MOS Technology 6502  
Intel 8086  
Motorola 6803  
Intel 80286  
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TI Explorer's 32-bit Lisp machine chip  
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Exponentially increasing computational capacity over time (computations per second) – Koomey, Berard, Sanchez, and Wong (2011)<sup>4</sup>



Computations per kWh

Eniac

EDVAC

Univac I

Univac II

Univac III (transistors)

SDS 920

DEC PDP-11/20

Cray 1 supercomputer

Altair 8800

IBM PC

IBM PC-AT

IBM PC-XT

Apple IIe

Commodore 64

Macintosh 128k

Compaq Deskpro 386/20e

486/25 and 486/33 Desktops

IBM PS/2 E + Sun SS1000

Dell Optiplex GXI

Gateway P3, 733 MHz

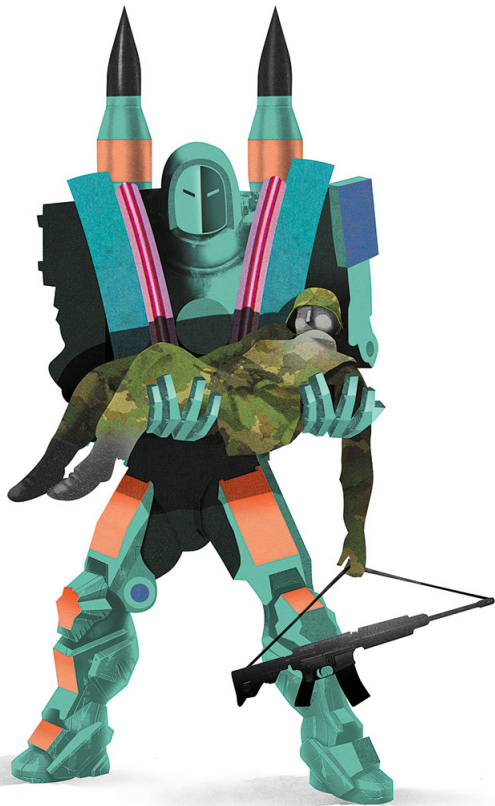
Dell Dimension 2400

SiCortex SC5832

Regression results:  
 N = 80  
 Adjusted R-squared = 0.983  
 Comps/kWh =  $\exp(0.4401939 \times \text{Year} - 849.1617)$   
 Average doubling time (1946 to 2009) = 1.57 years

Year





# The Great A.I. Awakening

How Google used artificial intelligence to transform Google Translate, one of its more popular services — and how machine learning is poised to reinvent computing itself.

BY GIDEON LEWIS-KRAUS DEC. 14, 2016



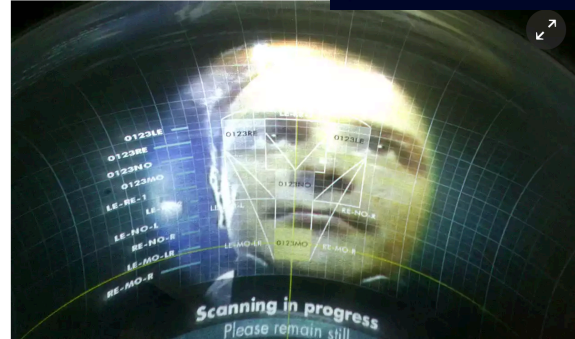
# Autopilot car takes driver to hospital



Joshua Neally said his car saved his life when a clot blo

# Face-reading AI will be your politics and IQ, prof

Professor whose study suggested technology could predict your politics or straight says programs will soon reveal traits

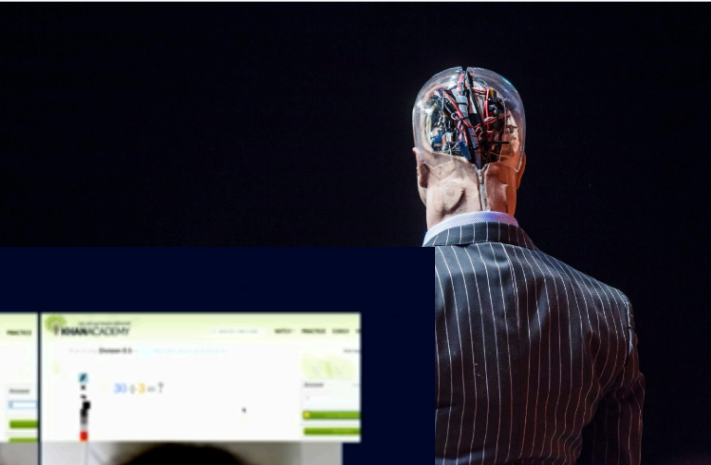


Your photo could soon reveal your political views, says a Stanford professor. Photograph: Frank Baron for the Guardian

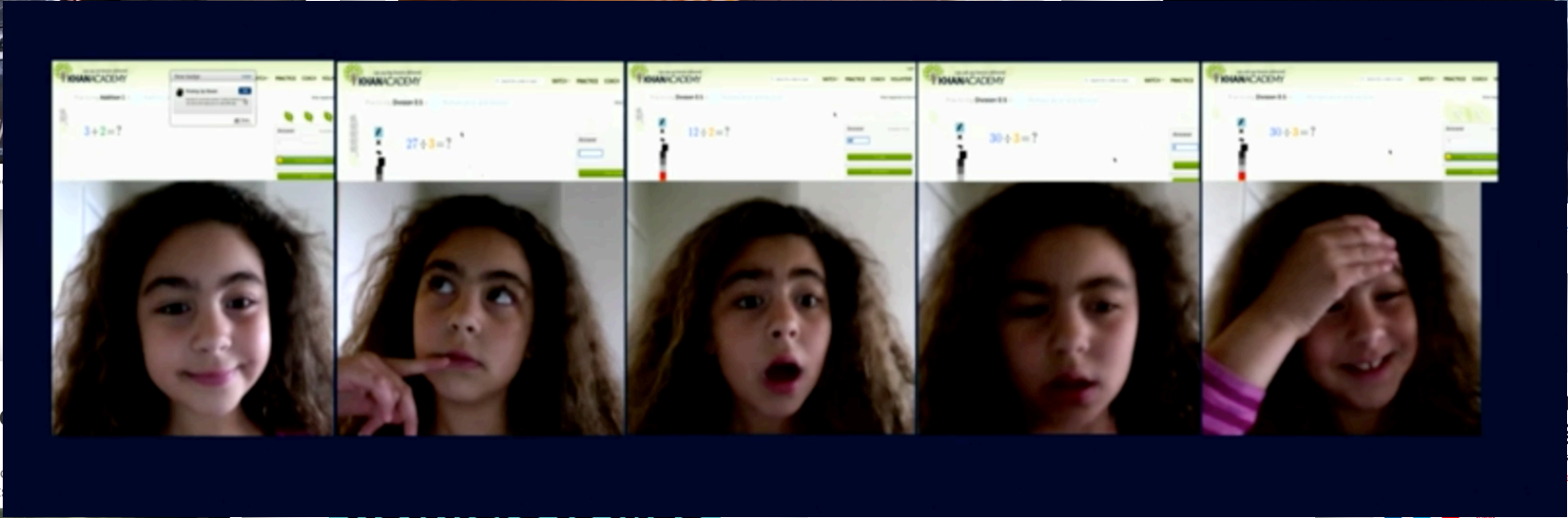


# TECH & SCIENCE HOW FACEBOOK'S AI BOTS LEARNED THEIR OWN LANGUAGE AND HOW TO LIE

BY KEVIN MANEY ON 8/5/17 AT 10:39 AM



bate, negotiate—and lie—like humans.



# Alibaba lets customers pay with facial recognition

at an ordering kiosk and entering a phone number

10K comments

Like Click to follow The Independent Online

# What machines can tell from your face



Getty Images

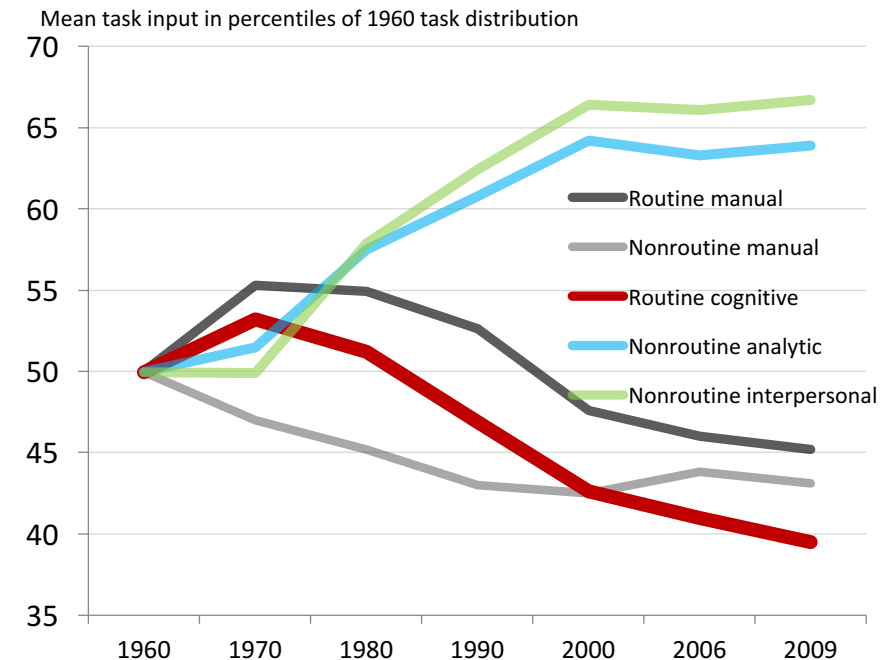


A customer tries Alipay's facial recognition payment solution "Smile to Pay" at KFC's new KPRO restaurant in Hangzhou, Zhejiang province, China REUTERS

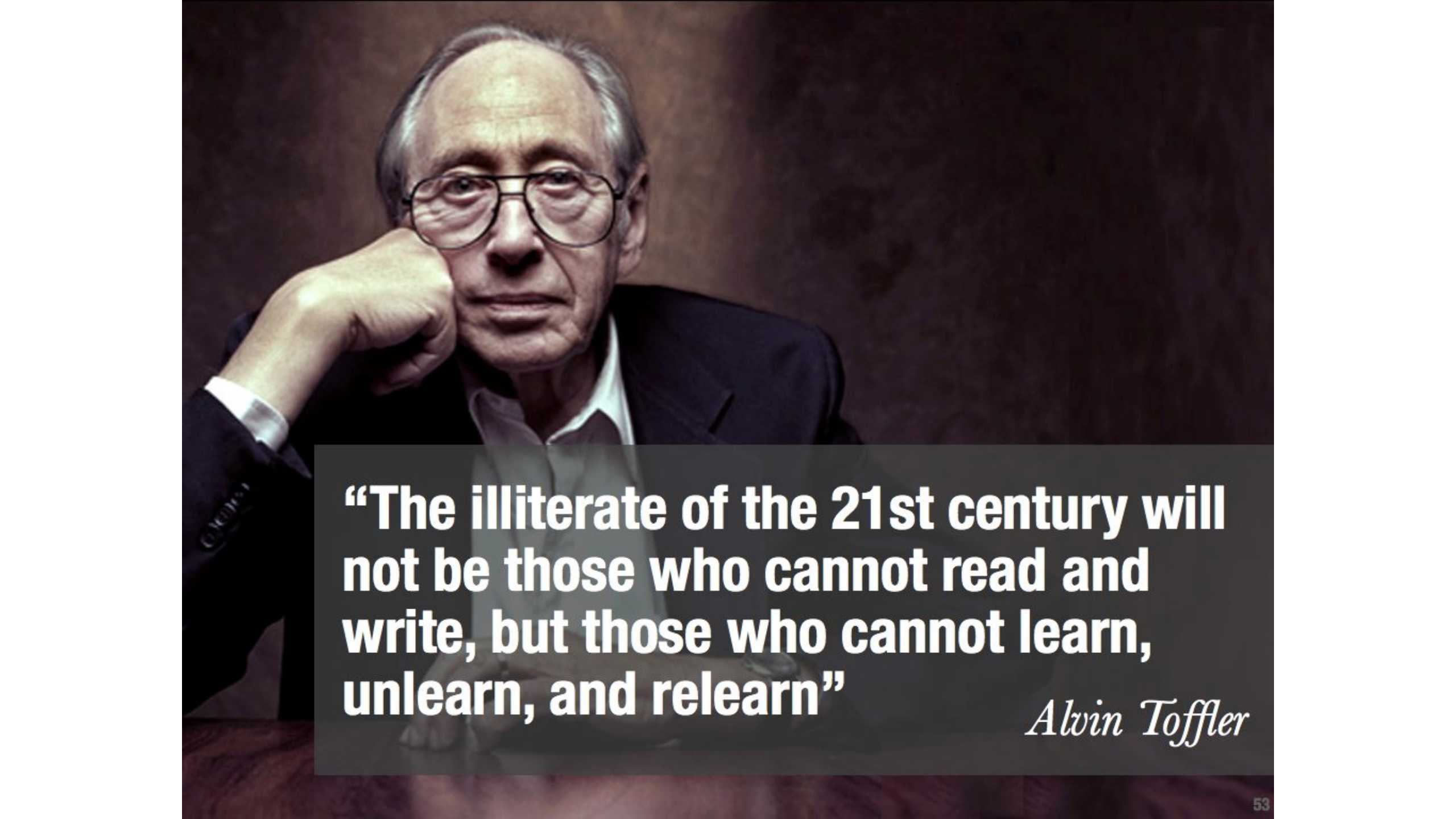




**The kind of things that  
are easy to teach are  
now easy to automate,  
digitize or outsource**





A portrait of Alvin Toffler, an older man with glasses, resting his chin on his hand. The background is dark and textured.

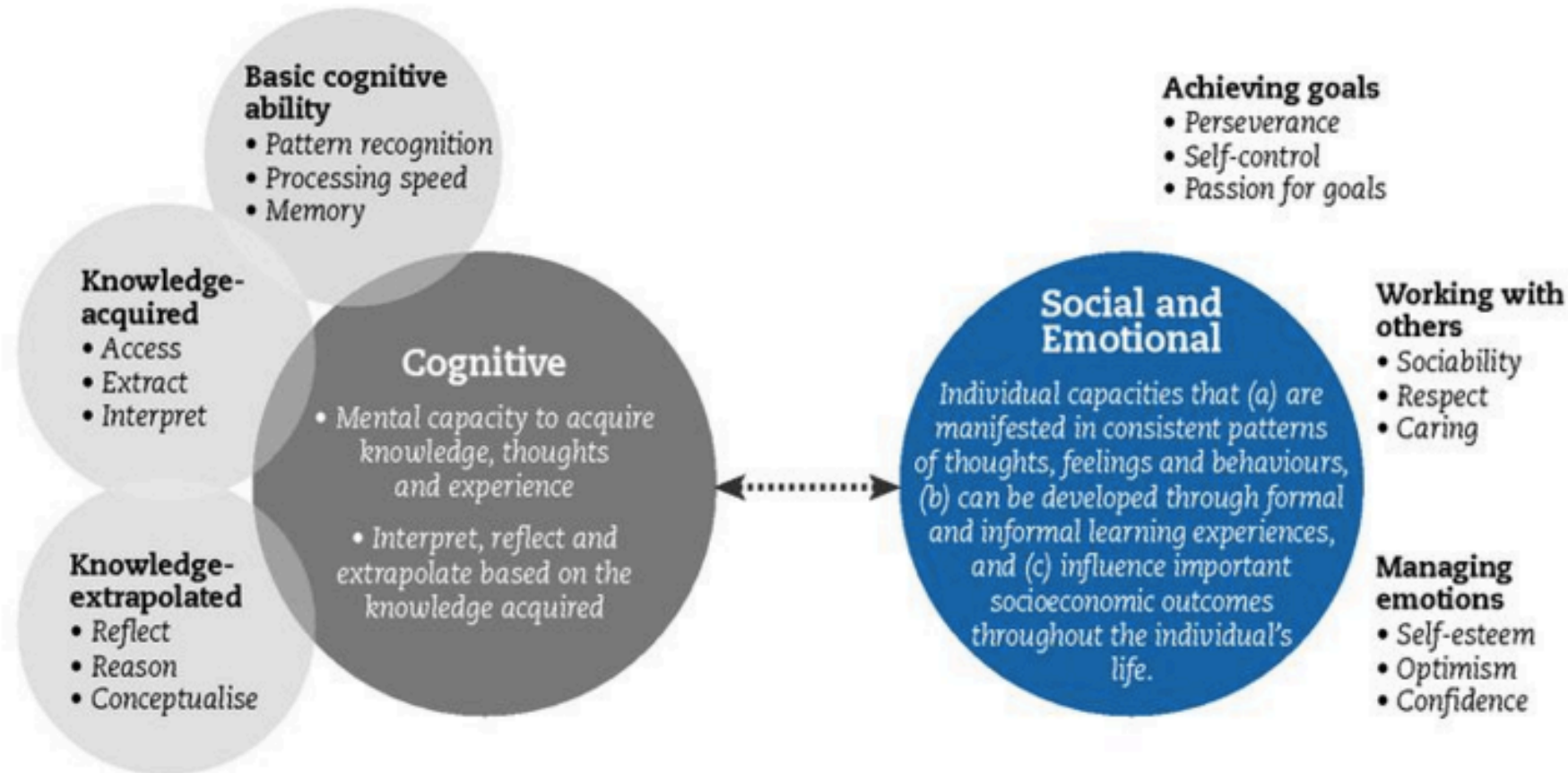
**“The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn”**

*Alvin Toffler*



# The New Vision for Education

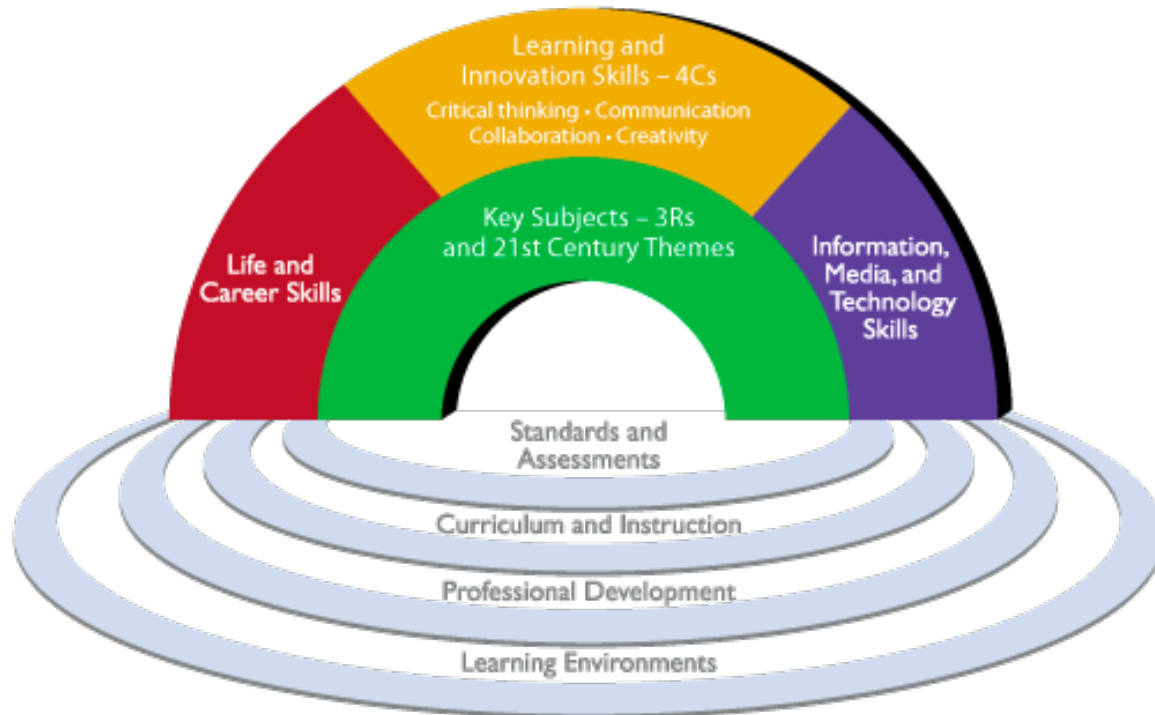
Figure 2.3. **A framework for cognitive, social and emotional skills**





## P21 Framework for 21st Century Learning

21st Century Student Outcomes and Support Systems



© 2007 Partnership for 21st Century Learning (P21)

[www.P21.org/Framework](http://www.P21.org/Framework)

### Key Subjects and 21st Century Themes

Mastery of key subjects and 21st century themes is essential to student success. Key subjects include English, reading or language arts, world languages, arts, mathematics, economics, science, geography, history, government and civics.

In addition, schools must promote an understanding of academic content at much higher levels by weaving 21st century interdisciplinary themes into key subjects:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy
- Environmental Literacy

### Learning and Innovation Skills

Learning and innovation skills are what separate students who are prepared for increasingly complex life and work environments in today's world and those who are not. They include:

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

### Information, Media and Technology Skills

Today, we live in a technology and media-driven environment, marked by access to an abundance of information, rapid changes in technology tools and the ability to collaborate and make individual contributions on an unprecedented scale. Effective citizens and workers must be able to exhibit a range of functional and critical thinking skills, such as:

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

### Life and Career Skills

Today's students need to develop thinking skills, content knowledge, and social and emotional competencies to navigate complex life and work environments. P21's essential Life and Career Skills include:

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



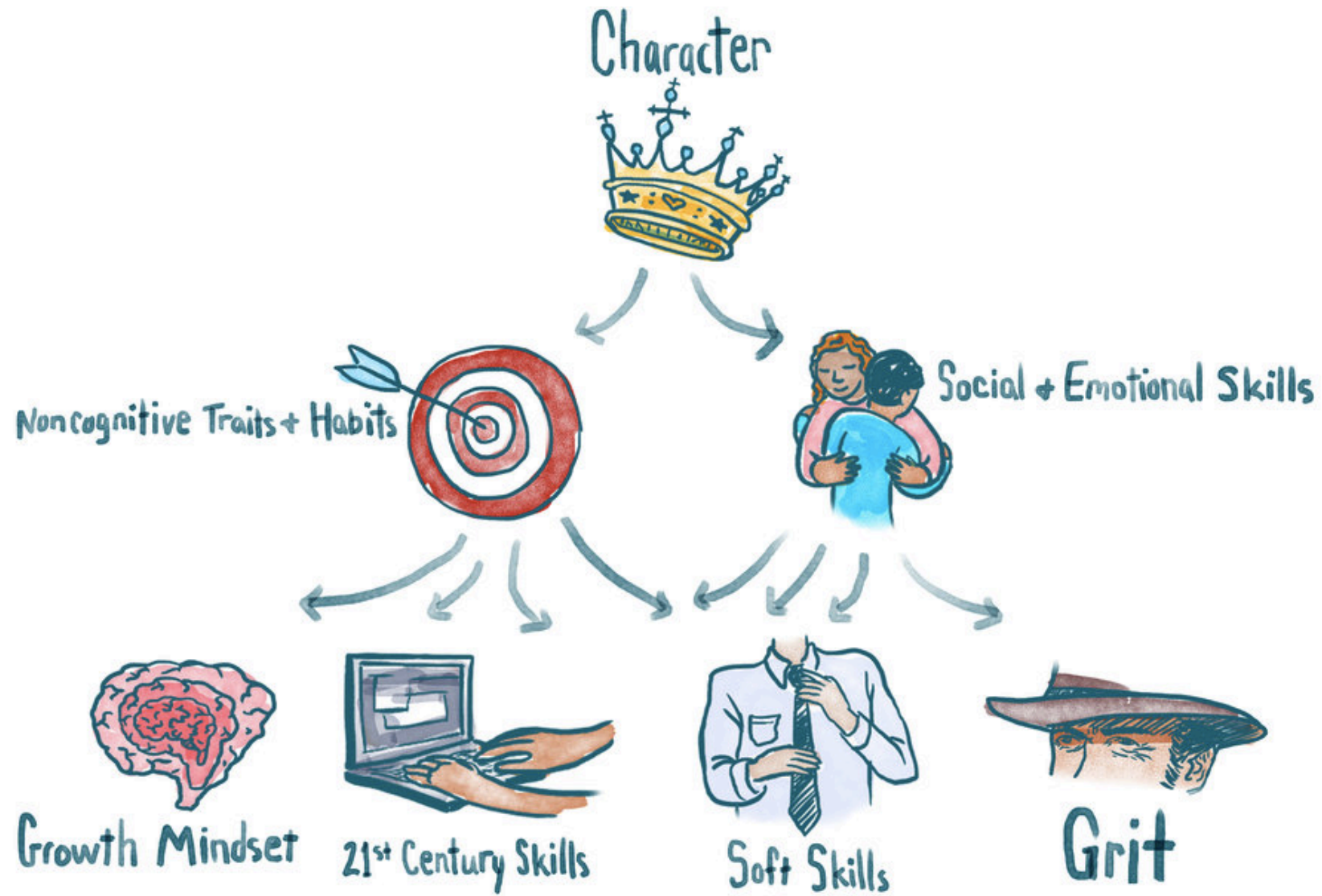
# 5 Essential Elements of PYP

Concepts	Skills	Knowledge	Attitudes	Action
What do we want the students to understand?	What do we want students to be able to do?	What do we want students to learn about?	What do we want students to feel, value, demonstrate?	How do we want students to act?
<b>8 Key concepts:</b> Important for design of Transdisciplinary Curriculum	<b>5 Transdisciplinary skills:</b> Approaches to Teaching	<b>6 Transdisciplinary Themes</b>	<b>12 Attitudes</b> we will encourage	<b>Effective, purposeful Action</b>
<ul style="list-style-type: none"> <li>• Form</li> <li>• Function</li> <li>• Causation</li> <li>• Reflection</li> <li>• Perspective</li> <li>• Change</li> <li>• Connection</li> <li>• Responsibility</li> </ul>	<ul style="list-style-type: none"> <li>• Thinking skills</li> <li>• Research skills</li> <li>• Social skills</li> <li>• Communication skills</li> <li>• Self-management skills</li> </ul>	<ul style="list-style-type: none"> <li>• Who We Are</li> <li>• Sharing The Planet</li> <li>• Where We Are in Place and Time</li> <li>• How We Express Ourselves</li> <li>• How the World Works</li> <li>• How We Organise Ourselves</li> </ul>	<ul style="list-style-type: none"> <li>• Appreciation</li> <li>• Commitment</li> <li>• Confidence</li> <li>• Co-operation</li> <li>• Creativity</li> <li>• Curiosity</li> <li>• Empathy</li> <li>• Enthusiasm</li> <li>• Independence</li> <li>• Integrity</li> <li>• Respect</li> <li>• Tolerance</li> </ul>	<ul style="list-style-type: none"> <li>• Modelled by adults</li> <li>• Voluntary</li> <li>• Own initiative</li> <li>• Based on concrete experiences</li> <li>• Can start small and grow</li> <li>• Reflection</li> <li>• Thoughtful and appropriate</li> <li>• Service to the community</li> </ul>

Develops International Mindedness

Internationally-minded individuals demonstrate the attributes of the **Learner Profile:**

Caring Balanced Risk-taker Inquirers Thinkers Knowledgeable Communicators  
Open-minded Principled Reflective



# Expectations for Learning are Changing

The new context means new expectations.

- Ability to communicate
- Adaptability to change
- Ability to work in teams
- Preparedness to solve problems
- Ability to analyse and conceptualise
- Ability to reflect on & improve performance
- Ability to manage oneself
- Ability to create, innovate and criticise
- Ability to engage in learning new things at all times
- Ability to cross specialist borders





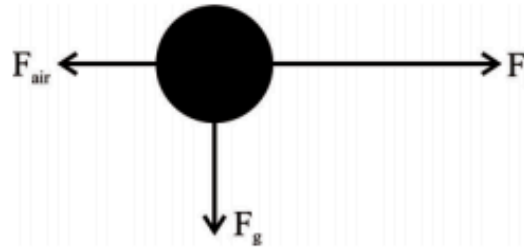
COMPREHENSION			EVALUATION		
KNOWLEDGE	APPLICATION	ANALYSIS	SYNTHESIS		
	Associate		Arrange	Appraise	
Cite	Classify		Assemble	Assess	
Count	Compare	Apply	Collect	Choose	
Define	Compute	Calculate	Compose	Compare	
Draw	Contrast	Classify	Construct	Criticize	
Identify	Differentiate	Demonstrate	Create	Determine	
List	Discuss	Determine	Design	Estimate	
Name	Distinguish	Dramatize	Formulate	Evaluate	
Point	Estimate	Employ	Integrate	Grade	
Quote	Explain	Examine	Manage	Judge	
Read	Express	Illustrate	Organize	Measure	
Recite	Extrapolate	Interpret	Plan	Rank	
Record	Interpolate	Locate	Prepare	Rate	
Repeat	Locate	Operate	Prescribe	Recommend	
		Order	Produce	Revise	
		Practice	Propose	Score	
		Report	Specify	Select	
		Structure	Synthesize	Standardize	
		Schedule	Test	Test	
		Match	Write	Validate	
		Give			
		Translate			
Place	Tell	Use			
Underline	Translate	Write			

Upper division  
Course / Program  
outcomes



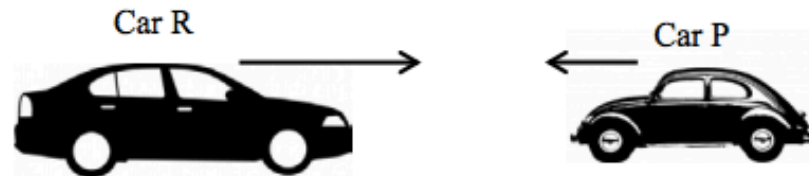
IEB NSC  
Physics  
P1 2015

- 1.4 A student draws the force diagram below showing the forces acting on a ball **after** it has been thrown. The ball is in mid-flight and is travelling horizontally to the right.



Which force, if any, is incorrect?

- A  $F_{\text{air}}$ , the force due to air resistance
  - B  $F_t$ , the force due to the throw
  - C  $F_g$ , the force due to gravity
  - D All of the forces are correct
- 1.5 Car R is travelling towards car P as shown in the diagram. Car R has a greater mass than car P and is moving faster. The two cars collide head on.

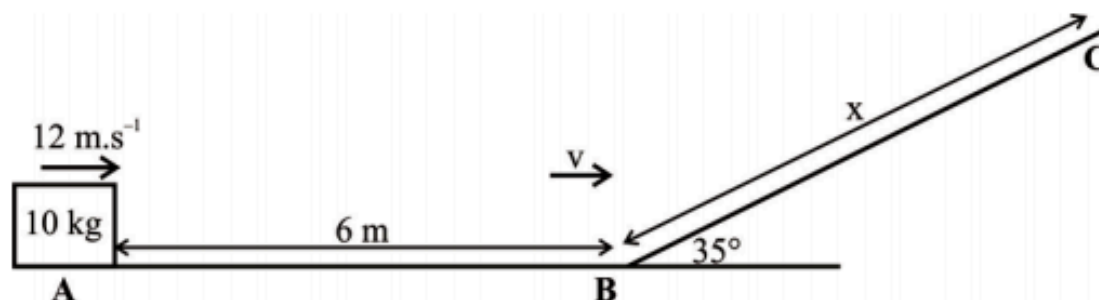


Which statement best describes the magnitudes of the forces experienced by the cars during the collision?

- A Car R experiences the greater force
- B Car P experiences the greater force
- C The cars experience equal forces
- D It depends on the ratio of the car's masses

**QUESTION 5      SLIDING BLOCK**

A block of mass 10 kg is sliding along a uniform rough surface. The surface is horizontal from A to B and inclined at  $35^\circ$  to the horizontal from B to C.



The block is travelling at a speed of  $12 \text{ m}\cdot\text{s}^{-1}$  as it passes A.

5.1 Define the term *kinetic energy*. (2)

5.2 Calculate the kinetic energy of the block as it passes A. (3)

The frictional force acting on the block as it slides from A to B is **54,9 N**.

5.3 State the *work-energy theorem*. (2)

5.4 Calculate the speed of the block ( $v$ ) as it reaches B. (4)

The block slides up the incline from B and comes to rest at C. The frictional force acting on the block as it slides from B to C is **45,0 N**.

5.5 Write an expression for the potential energy of the block at C in terms of  $x$  (the distance along the slope from B to C). (2)

5.6 Calculate the distance,  $x$ , that the block slides up the slope before coming to rest at C. (5)

# Expectations for Learning are Changing

The new context means new expectations. Most studies include:

- Ability to communicate
- Adaptability to change
- Ability to work in teams
- Preparedness to solve problems
- Ability to analyse and conceptualise
- Ability to reflect on and improve performance
- Ability to manage oneself
- Ability to create, innovate and criticise
- Ability to engage in learning new things at all times
- Ability to cross specialist borders



## Queensland Australia Gr9 Maths - Instruction to Students:

**Your task is to design a space to store enough stackable chairs to seat all the staff and students in your school.**

- **You will:**
- follow a series of steps to help you design a suitable space
- use a research journal to record your ideas and rough working
- write a report on the process and solutions.

Note: We are still testing the content and whether students have mastered the underlying skills

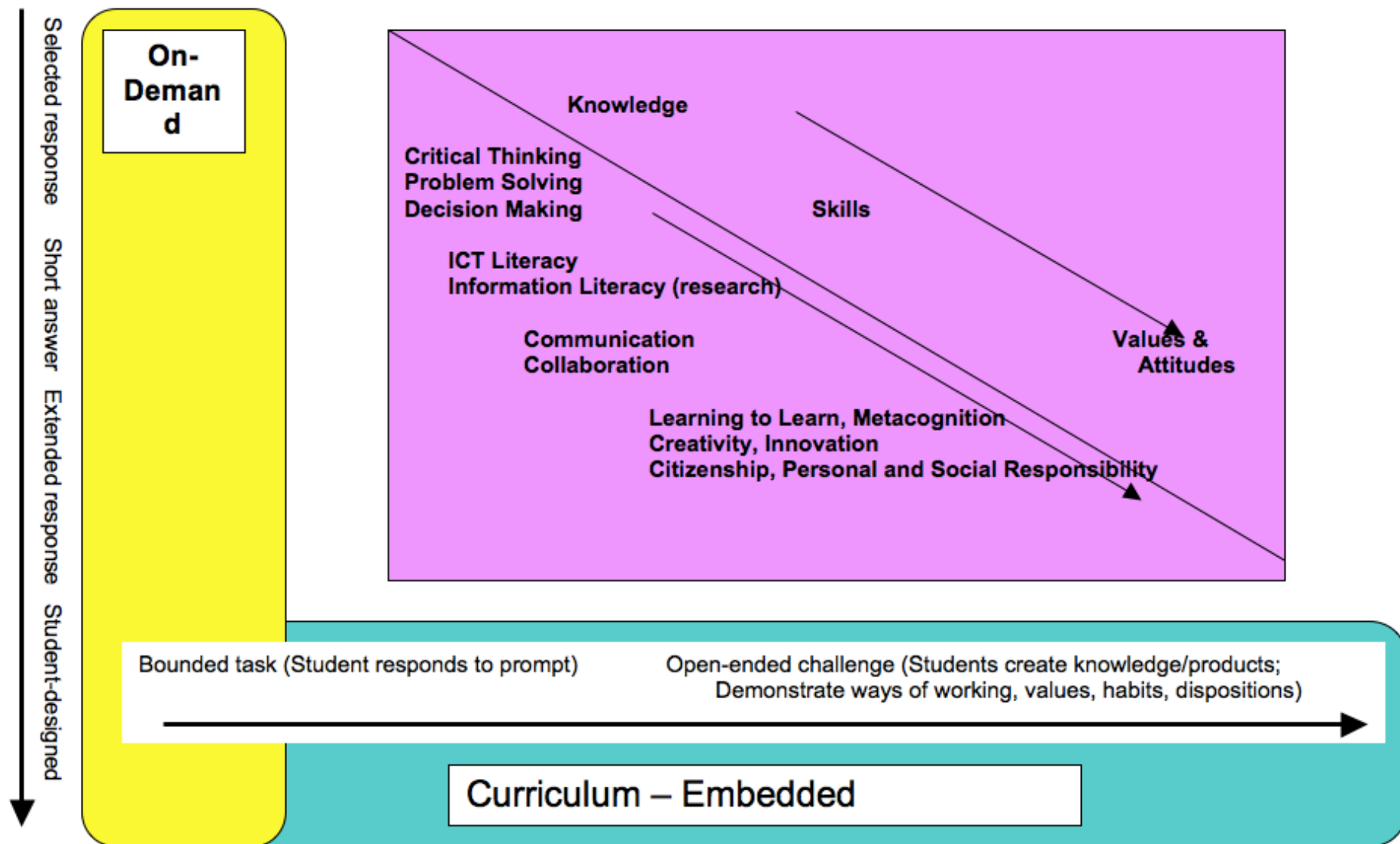
### **Questions**

1. Develop mathematical models for each dimension of a stack of chairs, where the number of chairs is unknown.
  2. To help you think about the practicalities of storing chairs, use your mathematical models to find:
    - a. the greatest number of chairs in one stack that can fit into a storage area with a 4 m high ceiling
    - b. the number of stacks that fit across a 3.2 m wide area if there are 10 chairs in each stack
    - c. the height of a stack, if all the chairs for the school are put into one stack.
  3. Use the understanding of the practicalities of storing chairs you developed in Question 2 to find a practical storage area for the chairs.
- To answer these questions, work through the steps set out on the following pages. As you work, record everything you do in your research journal.

### **Using a research journal**

- A research journal is a record of what you and your group do. Your research journal should include:
- what you and your group do in each class session, ideas, questions, plans, difficulties faced, how difficulties are managed, data collected, calculations, mathematical language, acknowledgment of any help you receive from friends, teachers or other people. Your research journal should contain all the information you need to write your report. It will also help your teacher decide what you can do by yourself, and what you can do as part of a group.

**Communicating your Findings** → Write a report on your investigation. Your report should include:



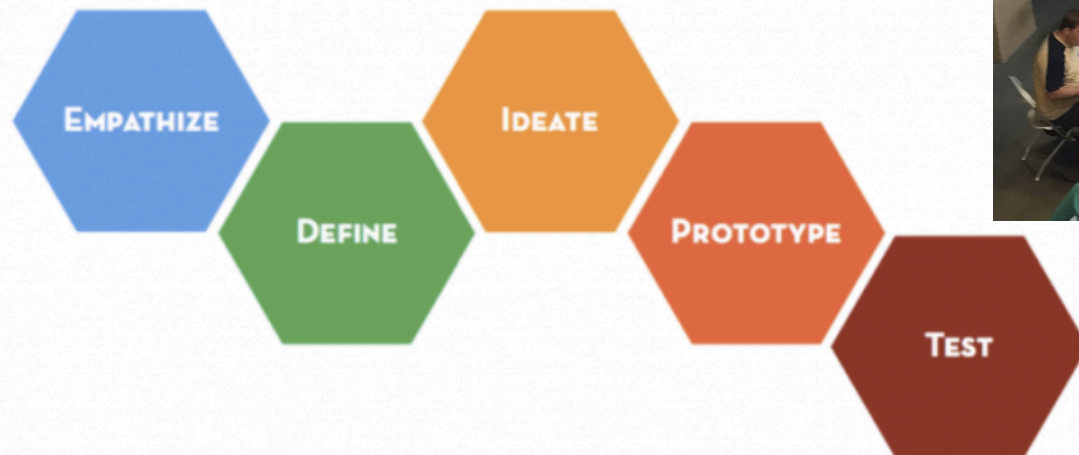
The future is  
already here,  
it is just unevenly  
distributed.

William Gibson  
author of Neuromancer

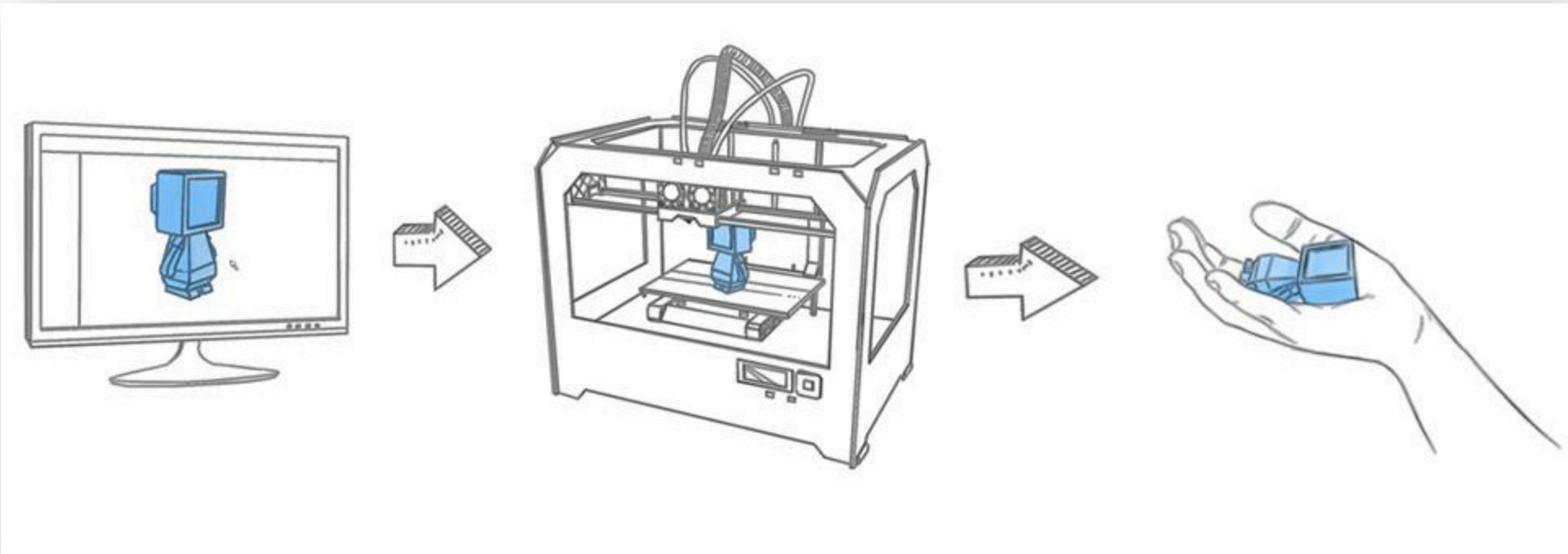




Design thinking...



# 3-D Printing









# Esther Wojcicki – Palo Alto High School's journalism program



Student newspaper, website, magazine, videos etc.

- Videography
- Photography
- Deadlines
- Collaboration
- Inter-personal relations management
- Design
- Planning
- Writing
- Editing
- Project-management
- Printing
- Budgeting
- Formatting

Students are judged by more complex outputs over a longer period of time.

## Education literature

## Principals are 2<sup>nd</sup> to teachers

In terms of their importance for  
student learning & school  
effectiveness .

“Indeed, there are virtually no documented instances of troubled schools being turned around without intervention by a powerful leader. Many other factors may contribute to such turnarounds, but leadership is the catalyst”

(Leithwood *et al.*, 2004:7 review of case studies of school leadership in the U.S. and Europe)

## Economics literature

# Principals are 2<sup>nd</sup> to teachers

In terms of their importance for  
student learning & school  
effectiveness .

After isolating out the contribution of students' background, school  
characteristics, teacher quality...

A highly effective principal can raise the achievement of the  
average student by **2-7 months of learning in a year**. A highly in  
ineffective one can lower achievement by the same amount.

(Branch, Hanushek & Rivkin 2012; see also Coelli & Green 2012;  
Grissom, Kalogrides & Loeb 2012; Chiang, Lipscomb & Gill 2012)



Economics  
literature

## Principals are 2<sup>nd</sup> to teachers

In terms of their importance for  
student learning & school  
effectiveness .

Impact:



Quality of  
principal



Quality of  
individual  
teacher

# Questions for reflection...

1. Are we **teaching, assessing** and **managing** our students and staff the same way we did 5 years ago?
2. How regularly am I leaving my **comfort zone**? Go to the places that scare you.
3. When was the **last time I failed** at something new I was trying out?
4. Am I a good model to my staff and students of how to **adapt to change**?
5. In what ways do I allow/encourage students to teach me and my staff about **technology**?



- ©Marty Bucella [www.martybucella.com](http://www.martybucella.com)
- 
- A black and white cartoon illustration. In the foreground, a woman with short hair, wearing glasses and a dark top, is seated at a desk, looking towards the right. She is holding a piece of paper. Behind her, a man and a woman are seated at the same desk. The man, with dark hair and a suit, is looking at the woman. The woman, with curly hair and a dark top, is looking at the man. On the desk, there is a computer monitor displaying a simple line drawing, a keyboard, and a mouse. A sign on the wall behind them reads "PRINCIPAL". The cartoon is signed "Bucella" in the bottom left corner.
- "I think it's time you discuss the facts of life with your son. He's been telling his classmates you got him on eBay."







Questions & comments?

*Presentation available at [nicspaull.com](http://nicspaull.com)*

© MARK ANDERSON

WWW.ANDERTOONS.COM



"It was a matter of principal! And unfortunately,  
the vice-principal."



# Resources

<https://www.ideo.com/expertise/education/>

<https://vimeo.com/40895671>

[http://education.vermont.gov/documents/EDU-WhitePaper-Making\\_Good\\_Use-of\\_New\\_Assessments.pdf](http://education.vermont.gov/documents/EDU-WhitePaper-Making_Good_Use-of_New_Assessments.pdf)



TEDxManhattanBeach - Paulo Blikstein - One Fabrication Lab per School: the FabLab@School project

TEDx

TEDx Talks

Subscribed 3,000,000

**Making Good Use of New Assessments:**

**Interpreting and Using Scores**

**From the Smarter Balanced Assessment Consortium**

Linda Darling-Hammond

Edward Haertel

James Pellegrino

With the Assistance of Soung Bae<sup>1</sup>

**March, 2015<sup>2</sup>**

Michael Fullan, Ken Robinson,  
Linda Darling-Hammond,  
Alaine De Botton, Carnegie  
Mellon University, d.school at  
Stanford

Released items -

<https://www.oecd.org/pisa/pisaproducts/PI-SA2015-Released-FT-Cognitive-Items.pdf>



## Examples

- Inter-grade teaching
- team teaching
- combined-subject teaching
- Explicitly teaching a curriculum of socio-emotional skills like empathy (21C skills)
- 'FuckUp Nights' – stories of failure
- Permanent high-speed wifi (obvs)
- Drone-building classes
- robotics classes in school time
- Arduinos
- Raspberry Pi (costs R500)
- coding classes
- MakerSpace labs / FabLabs
- 3D-printers



## Key Subjects and 21st Century Themes

Mastery of key subjects and 21st century themes is essential to student success. Key subjects include English, reading or language arts, world languages, arts, mathematics, economics, science, geography, history, government and civics.

In addition, schools must promote an understanding of academic content at much higher levels by weaving 21st century interdisciplinary themes into key subjects:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy
- Environmental Literacy

## Learning and Innovation Skills

Learning and innovation skills are what separate students who are prepared for increasingly complex life and work environments in today's world and those who are not. They include:

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

## Information, Media and Technology Skills

Today, we live in a technology and media-driven environment, marked by access to an abundance of information, rapid changes in technology tools and the ability to collaborate and make individual contributions on an unprecedented scale. Effective citizens and workers must be able to exhibit a range of functional and critical thinking skills, such as:

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

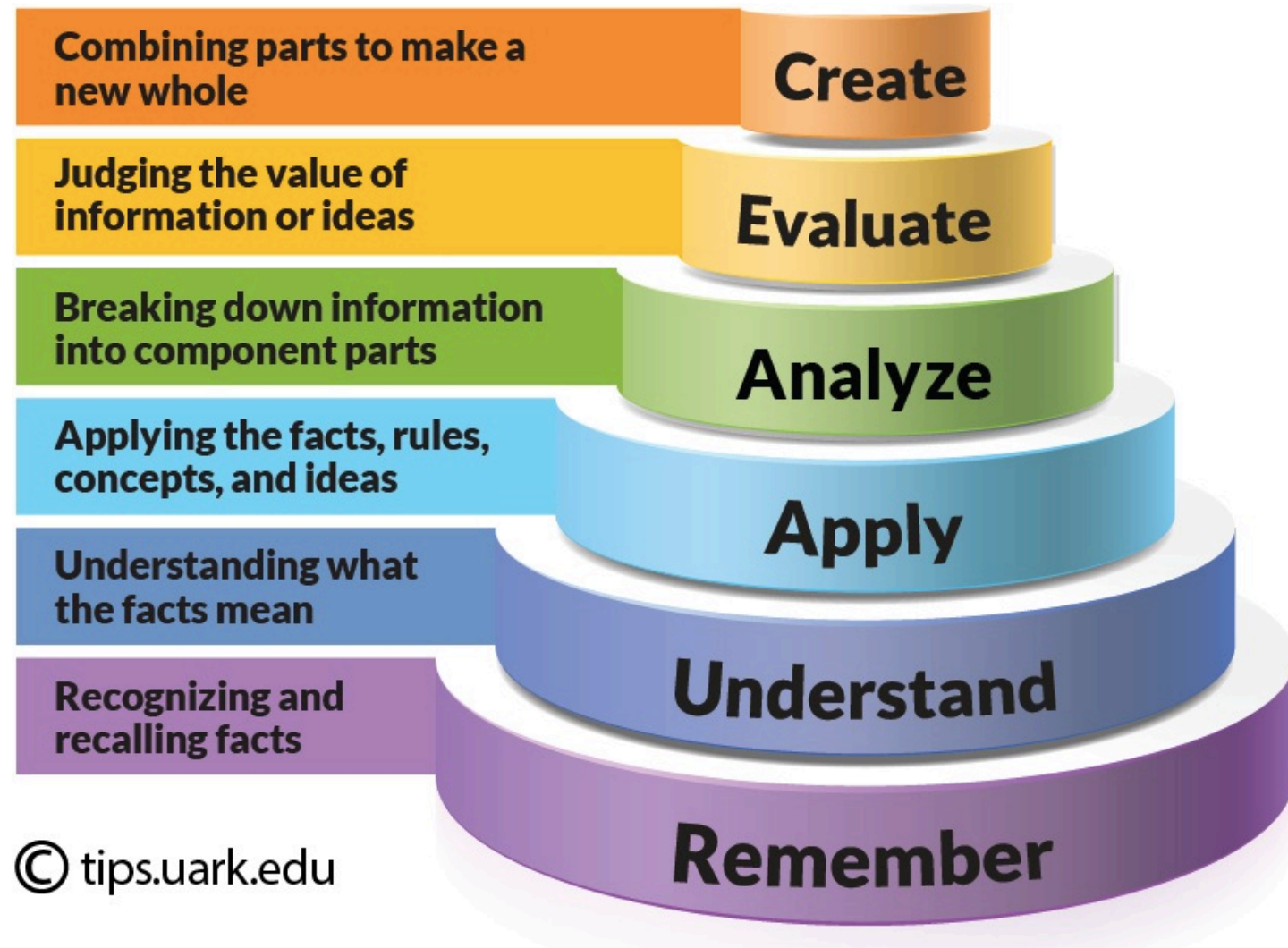
## Life and Career Skills

Today's students need to develop thinking skills, content knowledge, and social and emotional competencies to navigate complex life and work environments. P21's essential Life and Career Skills include:

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



# Bloom's Taxonomy: Cognitive

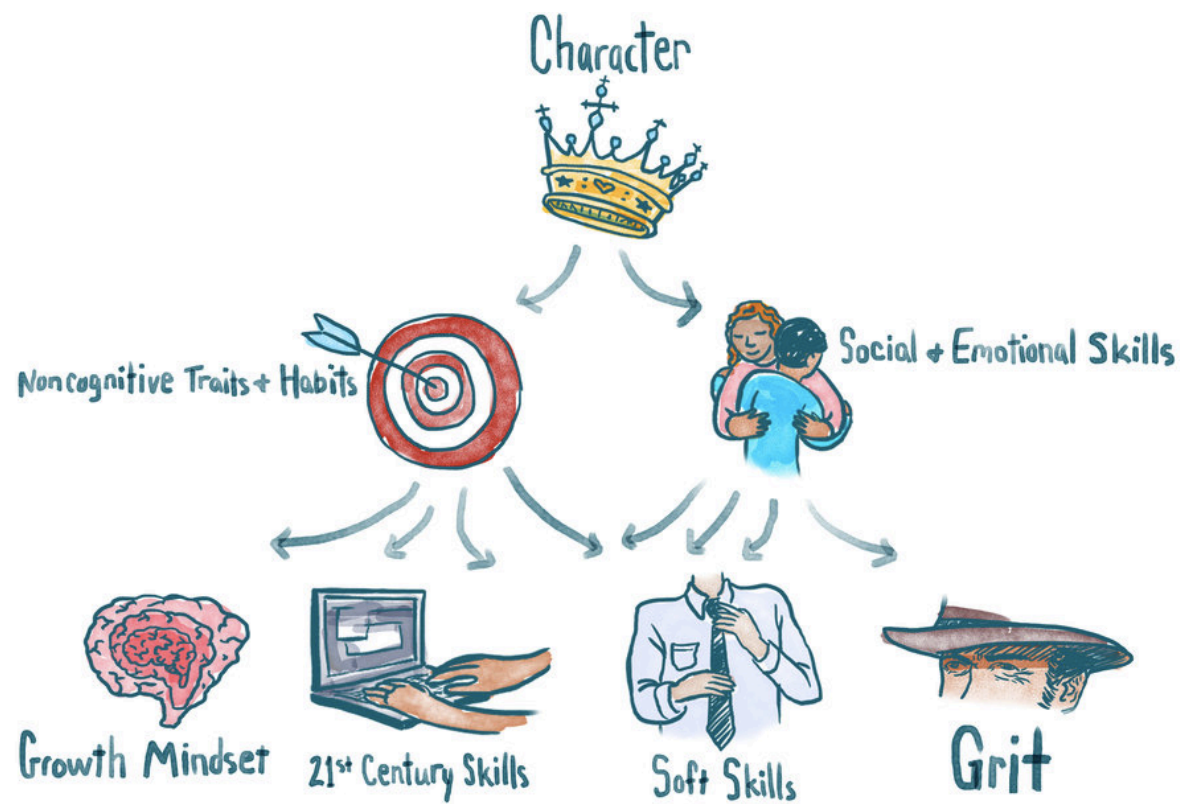




“Each team consists of four to six teachers and is responsible for 60 to 75 pupils. As an example of how they work, students in the eighth grade (13-year-olds) will often study earthquakes, volcanos and other earth forces - normally considered part of a geography or natural science lesson.

Now, however, teachers will come up with several different storylines for the lesson - encompassing other subjects In one, they pretend they have to climb Mount Everest.

It includes the study of maps, weather and climate, make a list of the equipment they need, calculate the time they will need, make a budget for the trip and apply for funding in English (a foreign language).”





# New



Perseverance  
and Tenacity



Long-Term  
Goal Oriented



Stick-to-it-ness  
Under Difficult  
Conditions

STICK  
TO IT!



Passion-Driven



Self-Control  
Self-Discipline



- Angela Duckworth – U Penn
- Carol Dweck - Stanford

