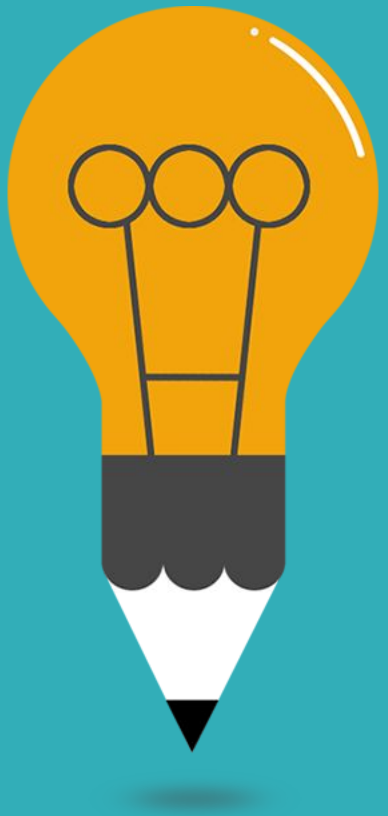


Critical Thinking, Coding & Algorithmic Thinking

Dr. Joanne Blannin
Digital Learning Leader
Melbourne Graduate School of Education

Dr. Joanne Blannin

Primary & secondary school leadership

DET - Digital Learning Branch

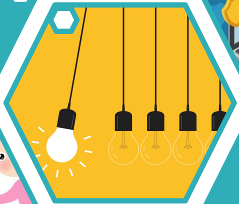
Worked with 400 Victorian Schools in past 5 years

Teaching in masters of Instructional Leadership

Research: leadership & technological change

International presenter – digital pedagogies

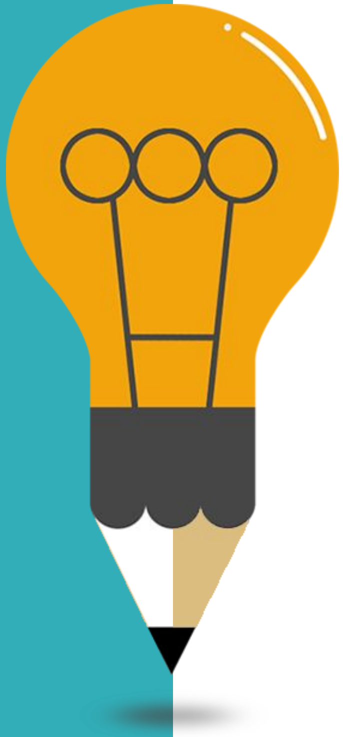
Outdoor education curriculum director



Private, Catholic & Independent schools

International research Fellow – learning spaces

Teaching: 4 countries in 3 languages



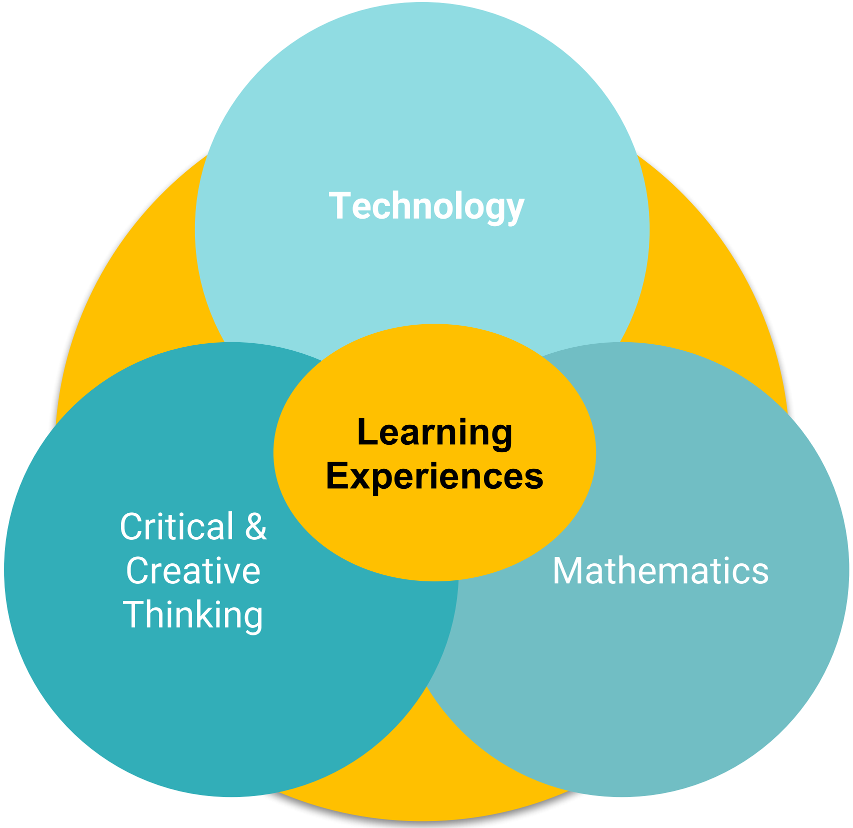
01 **General Capabilities**
Connecting ICT & Critical and Creative Thinking

02 **Leveraging Technology**
How, why and what?

03 **Robots & Coding**
Algorithms, and mathematical learning

04 **Virtual Reality, Machine Learning & Maths**
Bots and personalizing learning

05 **Technology for Mathematics learning**


Technology
Learning Experiences
Critical & Creative Thinking
Mathematics

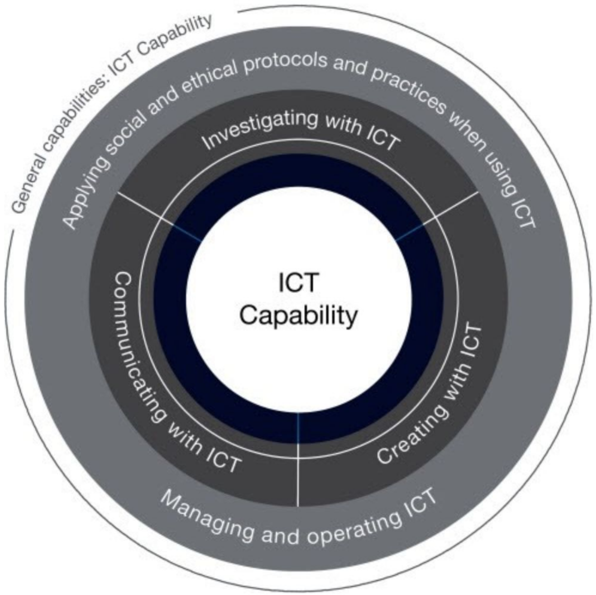
General Capabilities

In the Australian Curriculum, students develop Information and Communication Technology (ICT) capability as they learn to use ICT:

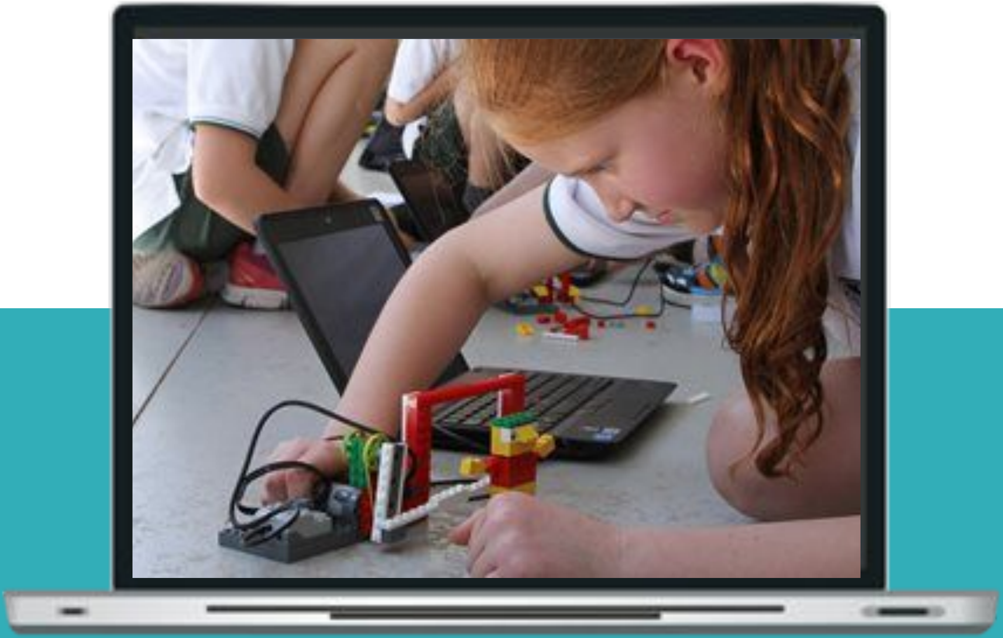
- Effectively and appropriately,
- To access, create and communicate information and ideas,
- To solve problems,
- And work collaboratively in all learning areas at school and in their lives beyond school

- … decision-making, communication, creative expression and empirical reasoning

ICT Capability



The nature and scope of ICT capability is not fixed, but is **responsive** to ongoing technological developments.



In the Australian Curriculum, students develop capability in **critical and creative thinking** as they learn to:

- Generate and evaluate knowledge
- Clarify concepts and ideas
- Seek possibilities,
- Consider alternatives,
- And solve problems.

- using skills, behaviours and dispositions such as reason, logic, resourcefulness, imagination and innovation…

Critical and Creative Thinking

General Capabilities Compared …

Information, Communication Technologies

Access, create & communicate information & ideas

Problem Solving

Use technology effectively & appropriately

… decision-making, communication, creative expression and empirical reasoning

Critical and Creative Thinking

Generate and evaluate knowledge

Problem Solving

Consider Alternatives

using skills, behaviours and dispositions such as reason, logic, resourcefulness, imagination and innovation…

Mathematics Curriculum

Victorian Curriculum – Level 4

Patterns and algebra

Describe, continue and create patterns with fractions, decimals and whole numbers resulting from addition and subtraction (VCMNA192)

Use equivalent number sentences involving multiplication and division to find unknown quantities (VCMNA193)

Follow a mathematical algorithm involving branching and repetition (iteration) (VCMNA194)

Mathematics Achievement Standard

National Curriculum – Level 4

Patterns and algebra

Describe, continue and create patterns with fractions, decimals and whole numbers resulting from addition and subtraction (ACMNA107 - Scootle)

Elaborations +

Find unknown quantities in number sentences involving multiplication and division and identify equivalent number sentences involving multiplication and division (ACMNA121 - Scootle)

Elaborations +

Critical and Creative Thinking learning continuum

Sub-element	Level 1 Typically, by the end of Foundation Year, students:	Level 2 Typically, by the end of Year 2, students:	Level 3 Typically, by the end of Year 4, students:	Level 4 Typically, by the end of Year 6, students:	Level 5 Typically, by the end of Year 8, students:	Level 6 Typically, by the end of Year 10, students:
Inquiring – identifying, exploring and organising information and ideas element						
Pose questions	pose factual and exploratory questions based on personal interests and experiences	pose questions to identify and clarify issues, and compare information in their world	pose questions to expand their knowledge about the world	pose questions to clarify and interpret information and probe for causes and consequences	pose questions to probe assumptions and investigate complex issues	pose questions to critically analyse complex issues and abstract ideas
Identify and clarify information and ideas	identify and describe familiar information and ideas during a discussion or investigation	identify and explore information and ideas from source materials	identify main ideas and select and clarify information from a range of sources	identify and clarify relevant information and prioritise ideas	clarify information and ideas from texts or images when exploring challenging issues	clarify complex information and ideas drawn from a range of sources
Organise and process information	gather similar information or depictions from given sources	organise information based on similar or relevant ideas from several sources	collect, compare and categorise facts and opinions found in a widening range of sources	analyse, condense and combine relevant information from multiple sources	critically analyse information and evidence according to criteria such as validity and relevance	critically analyse independently sourced information to determine bias and reliability
Generating ideas, possibilities and actions element						
Imagine possibilities and connect ideas	use imagination to view or create things in new ways and connect two things that seem different	build on what they know to create ideas and possibilities in ways that are new to them	expand on known ideas to create new and imaginative combinations	combine ideas in a variety of ways and from a range of sources to create new possibilities	draw parallels between known and new ideas to create new ways of achieving goals	create and connect complex ideas using imagery, analogies and symbolism
Consider alternatives	suggest alternative and creative ways to approach a given situation or task	identify and compare creative ideas to think broadly about a given situation or problem	explore situations using creative thinking strategies to propose a range of alternatives	identify situations where current approaches do not work, challenge existing ideas and generate alternative solutions	generate alternatives and innovative solutions, and adapt ideas, including when information is limited or conflicting	speculate on creative options to modify ideas when circumstances change
Seek solutions and put ideas into action	predict what might happen in a given situation and when putting ideas into action	investigate options and predict possible outcomes when putting ideas into action	experiment with a range of options when seeking solutions and putting ideas into action	assess and test options to identify the most effective solution and to put ideas into action	predict possibilities, and identify and test consequences when seeking solutions and putting ideas into action	assess risks and explain contingencies, taking account of a range of perspectives, when seeking solutions and putting complex ideas into action

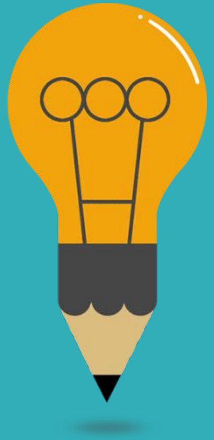
acara AUSTRALIAN CURRICULUM, ASSESSMENT AND REPORTING AUTHORITY
Australian CURRICULUM

Critical and Creative Thinking learning continuum

Sub-element	Level 1 Typically, by the end of Foundation Year, students:	Level 2 Typically, by the end of Year 2, students:	Level 3 Typically, by the end of Year 4, students:	Level 4 Typically, by the end of Year 6, students:	Level 5 Typically, by the end of Year 8, students:	Level 6 Typically, by the end of Year 10, students:
Reflecting on thinking and processes element						
Think about thinking (metacognition)	describe what they are thinking and give reasons why	describe the thinking strategies used in given situations and tasks	reflect on, explain and check the processes used to come to conclusions	reflect on assumptions made, consider reasonable criticism and adjust their thinking if necessary	assess assumptions in their thinking and invite alternative opinions	give reasons to support their thinking, and address opposing viewpoints and possible weaknesses in their own positions
Reflect on processes	identify the main elements of the steps in a thinking process	outline the details and sequence in a whole task and separate it into workable parts	identify pertinent information in an investigation and separate into smaller parts or ideas	identify and justify the thinking behind choices they have made	evaluate and justify the reasons behind choosing a particular problem-solving strategy	balance rational and irrational components of a complex or ambiguous problem to evaluate evidence
Transfer knowledge into new contexts	connect information from one setting to another	use information from a previous experience to inform a new idea	transfer and apply information in one setting to enrich another	apply knowledge gained from one context to another unrelated context and identify new meaning	justify reasons for decisions when transferring information to similar and different contexts	identify, plan and justify transference of knowledge to new contexts
Analysing, synthesising and evaluating reasoning and procedures element						
Apply logic and reasoning	identify the thinking used to solve problems in given situations	identify reasoning used in choices or actions in specific situations	identify and apply appropriate reasoning and thinking strategies for particular outcomes	assess whether there is adequate reasoning and evidence to justify a claim, conclusion or outcome	identify gaps in reasoning and missing elements in information	analyse reasoning used in finding and applying solutions, and in choice of resources
Draw conclusions and design a course of action	share their thinking about possible courses of action	identify alternative courses of action or possible conclusions when presented with new information	draw on prior knowledge and use evidence when choosing a course of action or drawing a conclusion	scrutinise ideas or concepts, test conclusions and modify actions when designing a course of action	differentiate the components of a designed course of action and tolerate ambiguities when drawing conclusions	use logical and abstract thinking to analyse and synthesise complex information to inform a course of action
Evaluate procedures and outcomes	check whether they are satisfied with the outcome of tasks or actions	evaluate whether they have accomplished what they set out to achieve	explain and justify ideas and outcomes	evaluate the effectiveness of ideas, products, performances, methods and courses of action against given criteria	explain intentions and justify ideas, methods and courses of action, and account for expected and unexpected outcomes against criteria they have identified	evaluate the effectiveness of ideas, products and performances and implement courses of action to achieve desired outcomes against criteria they have identified

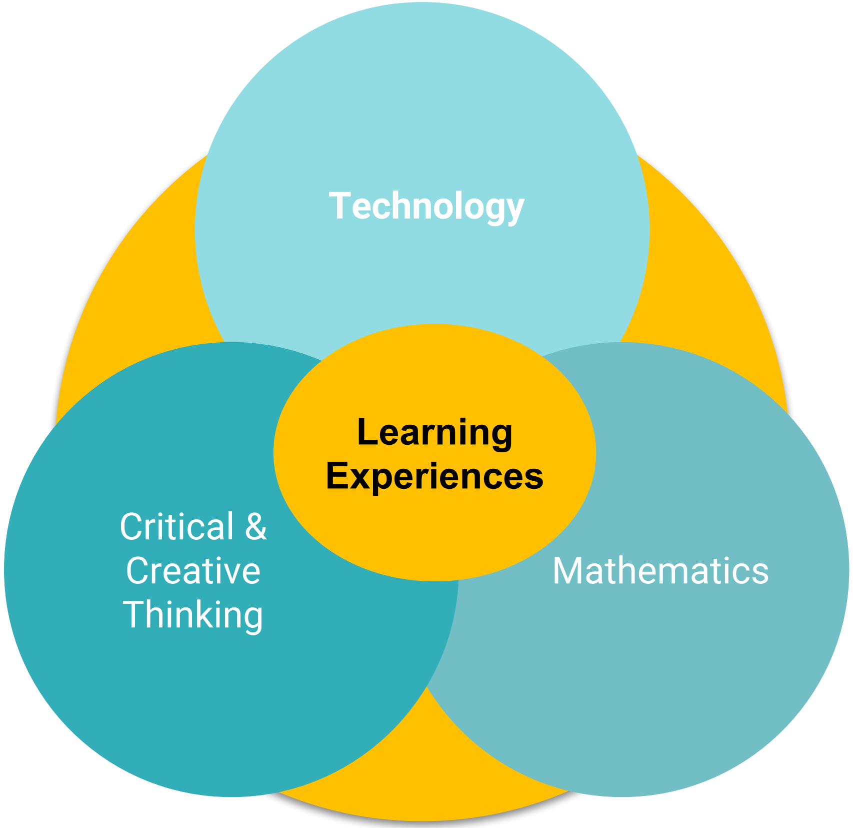
https://www.australiancurriculum.edu.au/media/1072/general-capabilities-creative-and-critical-thinking-learning-continuum.pdf

Examples of critical thinking skills are:



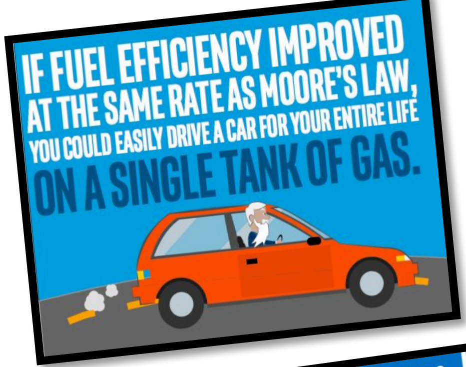
- ✓ Interpreting,
- ✓ Analysing,
- ✓ Evaluating,
- ✓ Explaining,
- ✓ Sequencing,
- ✓ Reasoning,
- ✓ Comparing,
- ✓ Questioning,
- ✓ Inferring,
- ✓ Hypothesising,
- ✓ Appraising,
- ✓ Testing, and
- ✓ Generalising.

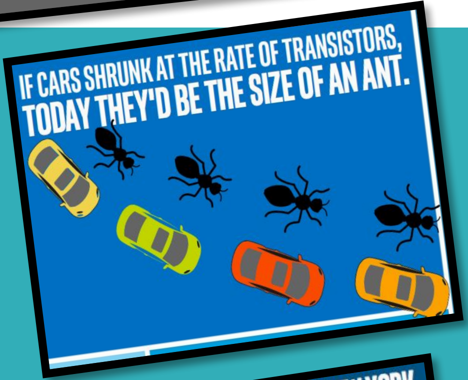
https://www.australiancurriculum.edu.au/f-10-curriculum/general-capabilities/critical-and-creative-thinking/

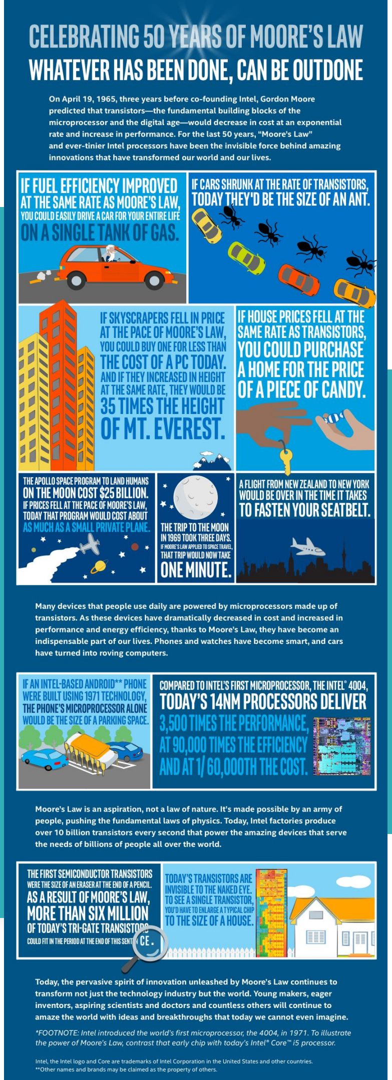

Technology
Learning Experiences
Critical & Creative Thinking
Mathematics

Leveraging Technology

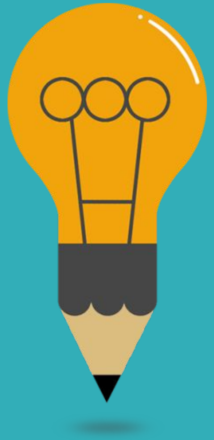
Predication: Tech will double in speed and halve in size every 18 months (Moore's law)







Reality….



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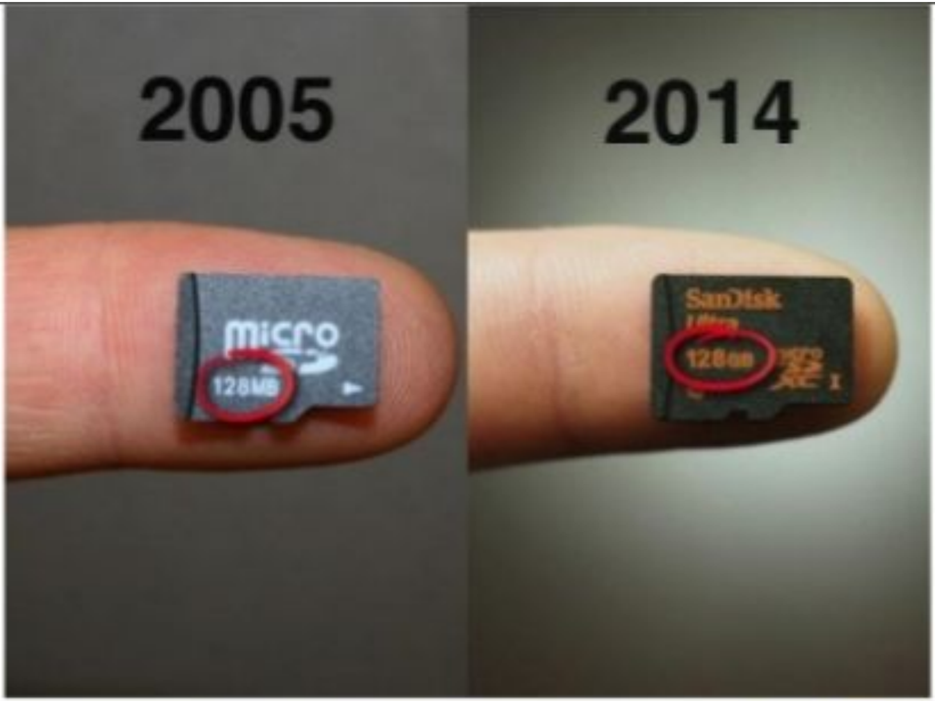
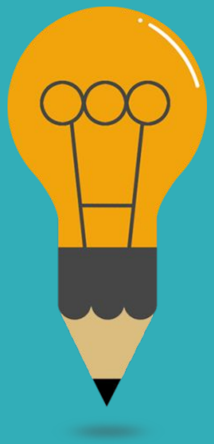


128GB

http://www.computerworld.com/article/2473980/data-storage-solutions/143723-Storage-now-and-then.html slide 2

@dw2



"We won’t experience 100 years of progress in the 21st century — it will be more like 20,000 years of progress (at today’s rate)"

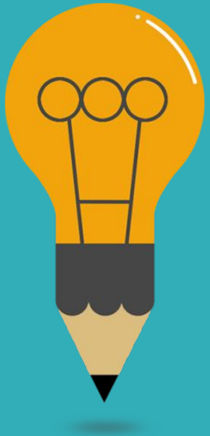
2001

Kurzweil in 2001. (BigThink)

"THE DOOR PROBLEM"

"So what does a game designer do? Are you an artist? Do you design characters and write the story? Or no, wait, you're a programmer?"

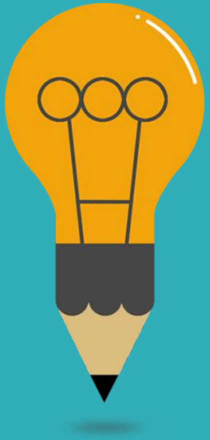
Game design is one of those nebulous terms to people outside the game industry that's about as clear as the "astrophysicist" job title is to me. It's also my job, so I find myself explaining what game design means to a lot of people from different backgrounds, some of whom don't know anything about games.



http://www.lizengland.com/blog/2014/04/the-door-problem/

Premise: You are making a game.

- Can the player open them?
- Can the player open every door in the game?
- Or are some doors for decoration?
- How does the player know the difference?
- Are doors you can open green and ones you can't red? Is there trash piled up in front of doors you can't use? Did you just remove the doorknobs and call it a day?
- Can doors be locked and unlocked?
- What tells a player a door is locked and will open, as opposed to a door that they will never open?
- Does a player know how to unlock a door? Do they need a key? To hack a console? To solve a puzzle? To wait until a story moment passes?
- Are there doors that can open but the player can never enter them?
- Where do enemies come from? Do they run in from doors? Do those doors lock afterwards?
- How does the player open a door? Do they just walk up to it and it slides open? Does it swing open? Does the player have to press a button to open it?
- Do doors lock behind the player?
- What happens if there are two players? Does it only lock after both players pass through the door?
- What if the level is REALLY BIG and can't all exist at the same time? If one player stays behind, the floor



Premise: You are making a game.

Do you stop one player from progressing any further until both are together in the same room?

Do you teleport the player that stayed behind?

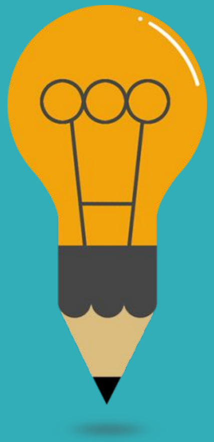
What size is a door?

Does it have to be big enough for a player to get through?

What about co-op players? What if player 1 is standing in the doorway – does that block player 2?

What about allies following you? How many of them need to get through the door without getting stuck?

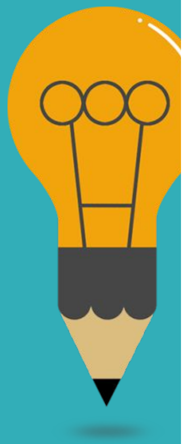
What about enemies? Do mini-bosses that are larger than a person also need to fit through the door?



The Other Door Problems

To help people understand the role breakdowns at a big company, I sometimes go into how other people deal with doors:

- **Creative Director**: "Yes, we definitely need doors in this game."
- **Project Manager**: "I'll put time on the schedule for people to make doors."
- **Designer**: "I wrote a doc explaining what we need doors to do."
- **Concept Artist**: "I made some gorgeous paintings of doors."
- **Art Director**: "This third painting is exactly the style of doors we need."
- **Environment Artist**: "I took this painting of a door and made it into an object in the game."
- **Animator**: "I made the door open and close."
- **Sound Designer**: "I made the sounds the door creates when it opens and closes."
- **Audio Engineer**: "The sound of the door opening and closing will change based on where the player is and what direction they are facing."
- **Composer**: "I created a theme song for the door."
- **FX Artist**: "I added some cool sparks to the door when it opens."
- **Writer**: "When the door opens, the player will say, 'Hey look! The door opened!' "
- **Lighter**: "There is a bright red light over the door when it's locked, and a green one when it's opened."



Legal: "The environment artist put a Starbucks logo on the door. You need to remove that if you don't want to be sued."

Character Artist: "I don't really care about this door until it can start wearing hats."

Gameplay Programmer: "This door asset now opens and closes based on proximity to the player. It can also be locked and unlocked through script."

AI Programmer: "Enemies and allies now know if a door is there and whether they can go through it."

Network Programmer: "Do all the players need to see the door open at the same time?"

Release Engineer: "You need to get your doors in by 3pm if you want them on the disk."

Core Engine Programmer: "I have optimized the code to allow up to 1024 doors in the game."

Tools Programmer: "I made it even easier for you to place doors."

Level Designer: "I put the door in my level and locked it. After an event, I unlocked it."

UI Designer: "There's now an objective marker on the door, and it has its own icon on the map."

Combat Designer: "Enemies will spawn behind doors, and lay cover fire as their allies enter the room. Unless the player is looking inside the door in which case they will spawn behind a different door."

Systems Designer: "A level 4 player earns 148xp for opening this door at the cost of 3 gold."

Monetization Designer: "We could charge the player $.99 to open the door now, or wait 24 hours for it to open automatically."

QA Tester: "I walked to the door. I ran to the door. I jumped at the door. I stood in the doorway until it closed. I saved and reloaded and walked to the door. I died and reloaded then walked to the door. I threw grenades at the door."

UX / Usability Researcher: "I found some people on Craigslist to go through the door so we could see what problems crop up."

Localization: “Door. Puerta. Porta. Porte. Tür. Dør. Deur. Drzwi. Drws. 문”

Producer: “Do we need to give everyone those doors or can we save them for a pre-order bonus?”

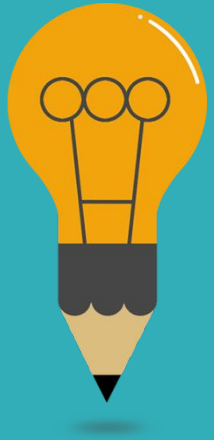
Publisher: “Those doors are really going to help this game stand out during the fall line-up.”

CEO: “I want you all to know how much I appreciate the time and effort put into making those doors.”

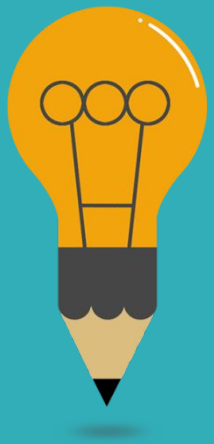
PR: “To all our fans, you’re going to go crazy over our next reveal #gamedev #doors #nextgen #retweet”

Community Manager: “I let the fans know that their concerns about doors will be addressed in the upcoming patch.”

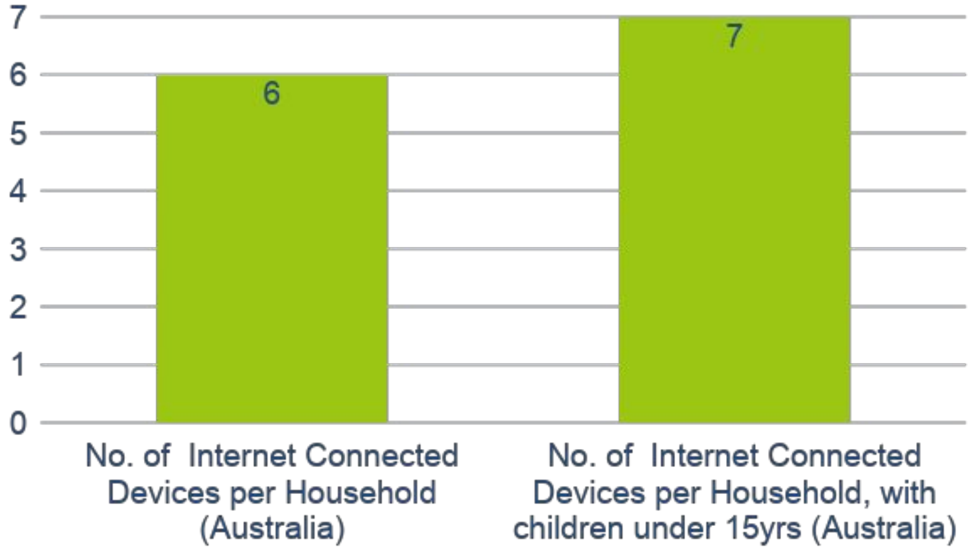
Customer Support: “A player contacted us, confused about doors. I gave them detailed instructions on how to use them.”



Player: “I totally didn’t even notice a door there.”

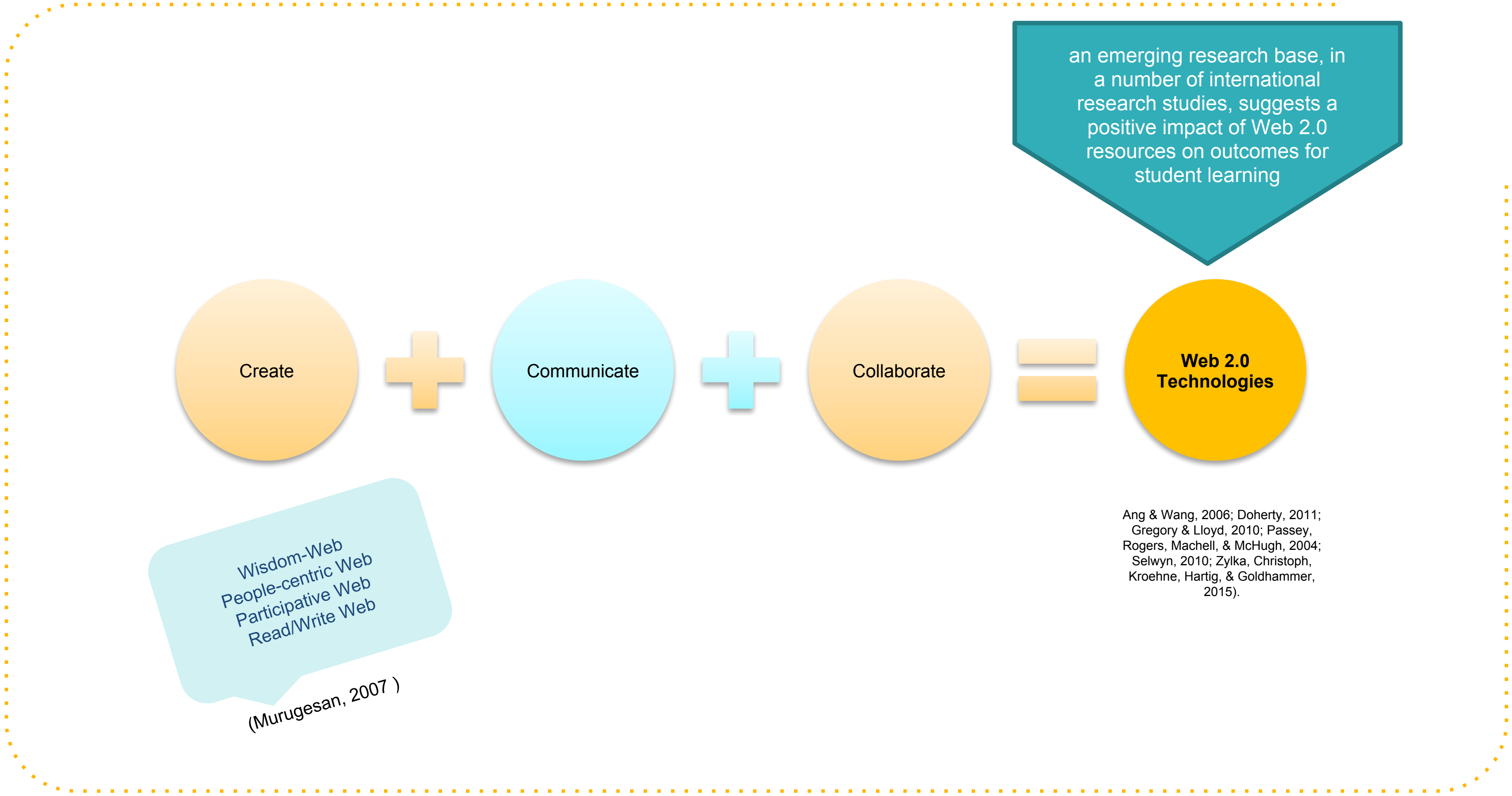


Internet Devices per Household in Australia (Australian Bureau of Statistics, 2016)



Australian Household Internet Access

“The difference in the participation rates was not statistically significant between children living in major cities (91%) and remote and very remote areas of Australia (88%)” (Australian Bureau of Statistics, 2016).


an emerging research base, in a number of international research studies, suggests a positive impact of Web 2.0 resources on outcomes for student learning
Create
Communicate
Collaborate
Web 2.0 Technologies
Wisdom-Web
People-centric Web
Participative Web
Read/Write Web
(Murugesan, 2007)
Ang & Wang, 2006; Doherty, 2011; Gregory & Lloyd, 2010; Passey, Rogers, Machell, & McHugh, 2004; Selwyn, 2010; Zylka, Christoph, Kroehne, Hartig, & Goldhammer, 2015).

Robots & Coding

MENU

New Words!

Algorithm

Say it with me: Al-go-ri-thm

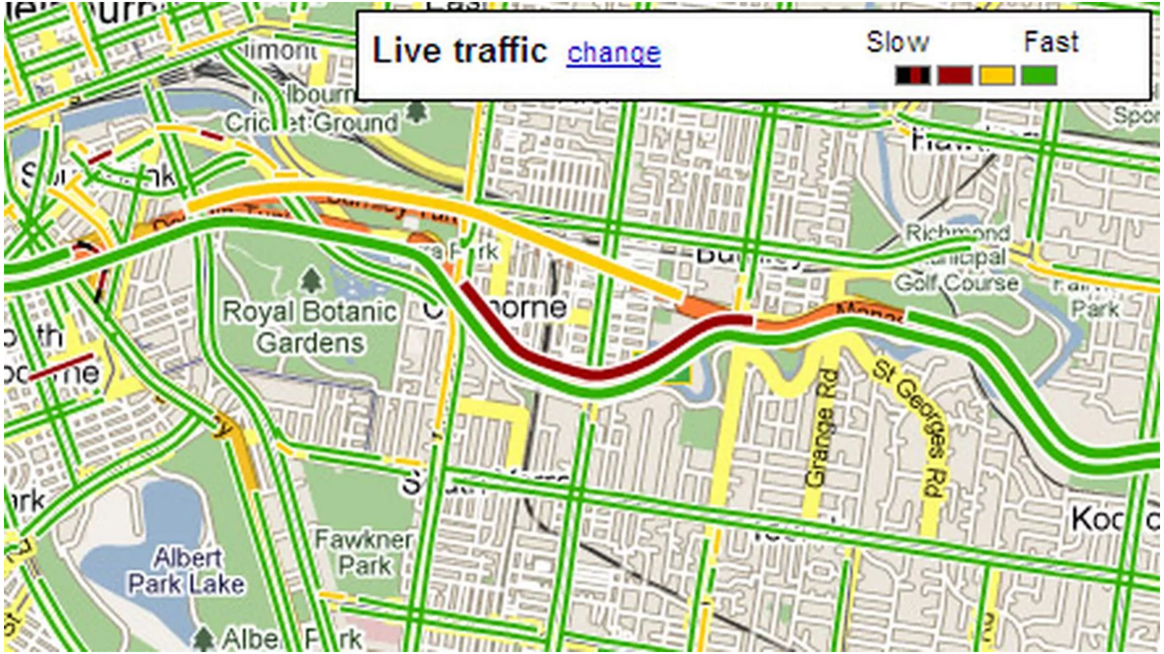
A list of steps that you can follow to finish a task

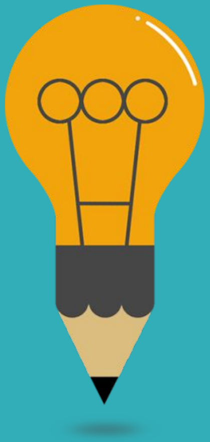
Program

Say it with me: Pro-gram

An algorithm that has been coded
into something that can be run by a machine

You might have experienced the power of an algorithm when the information you were looking for was at the **top of your search results** or when your **GPS device suggested another travel route based on traffic.**





Australian Curriculum definition of:

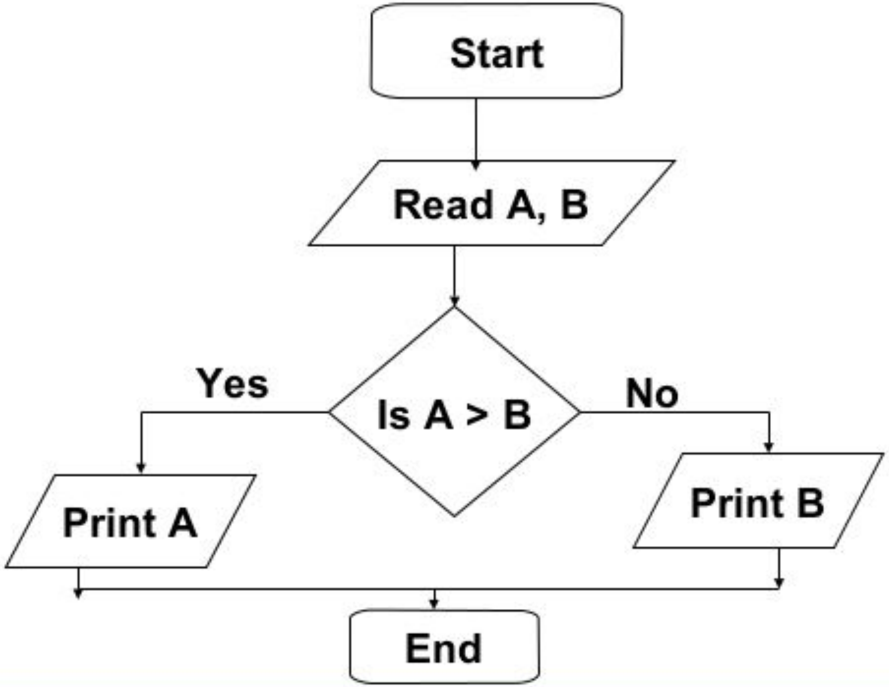
Algorithms

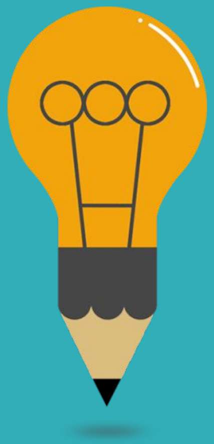
"Step-by-step procedures required to solve a problem."

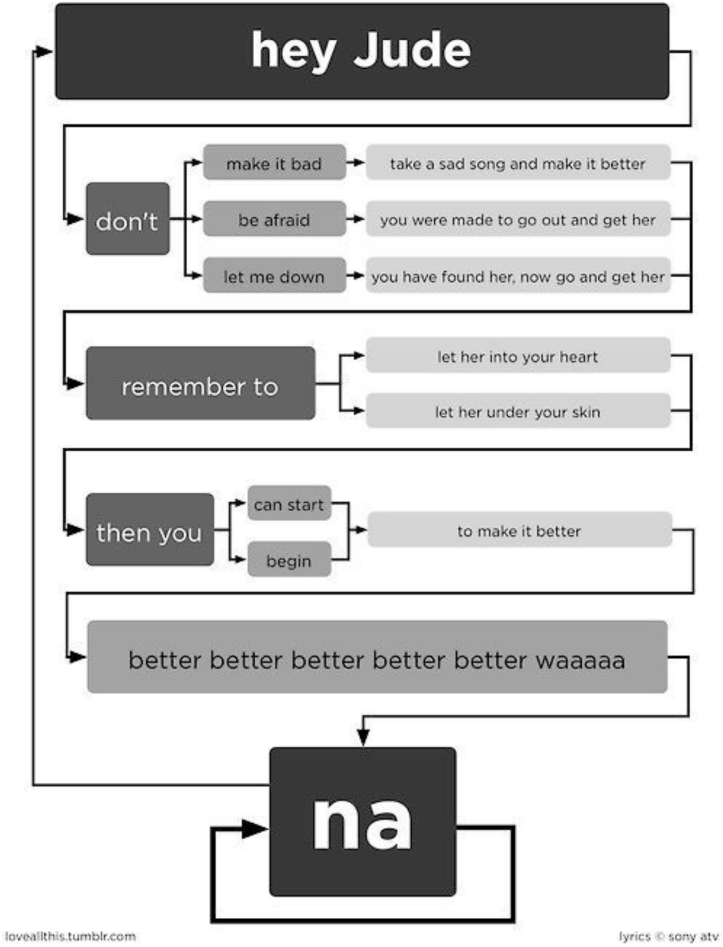
An *algorithm* may be described in many ways.

Flowcharts are often useful in visualising an *algorithm*.

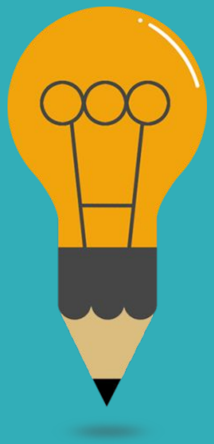
Flow Chart to find largest of two numbers:

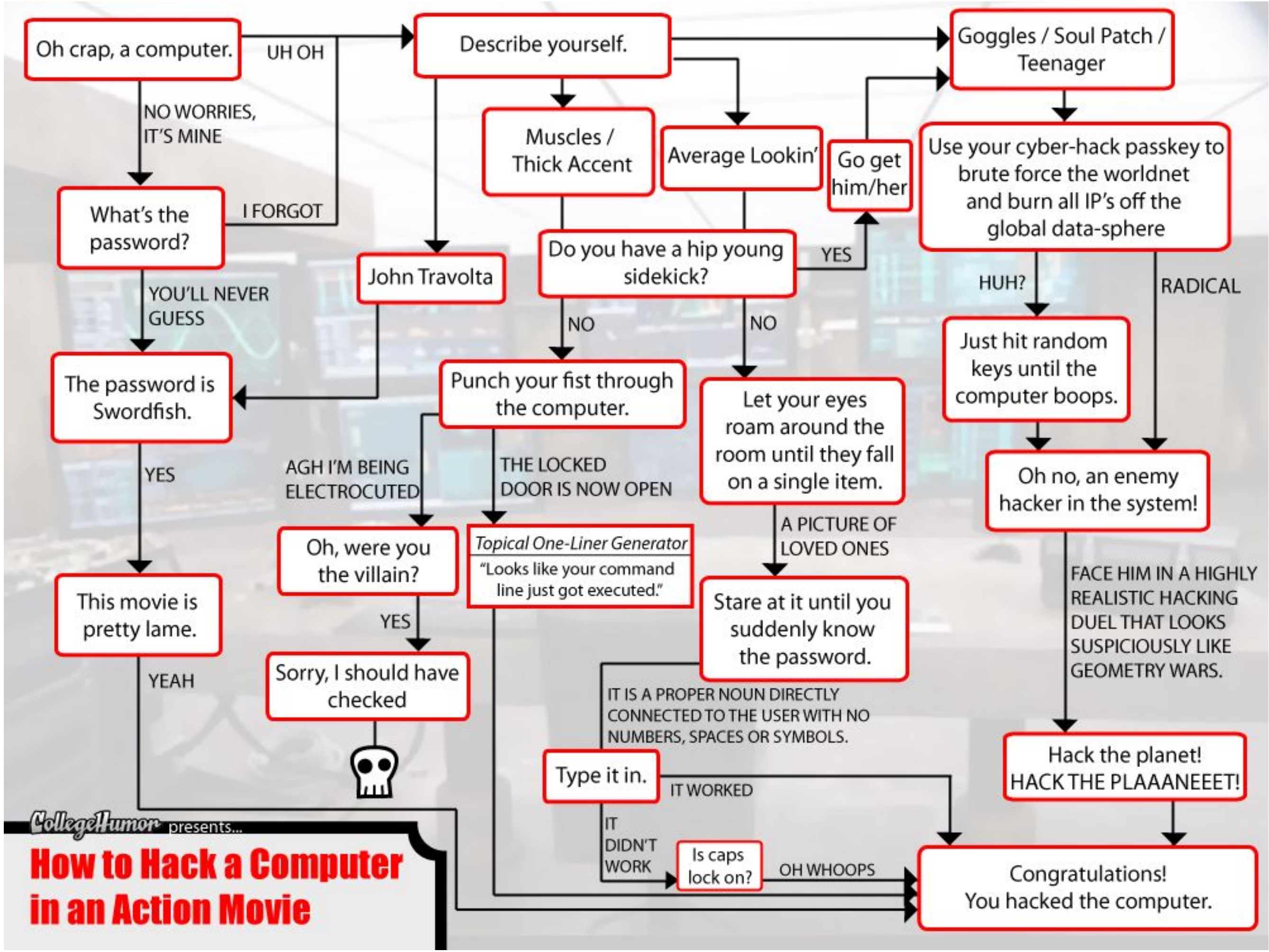






hey Jude
don't
make it bad
take a sad song and make it better
be afraid
you were made to go out and get her
let me down
you have found her, now go and get her
remember to
let her into your heart
let her under your skin
then you
can start
begin
to make it better
better better better better better waaaaa
na
loveallthis.tumblr.com
lyrics © sony atv

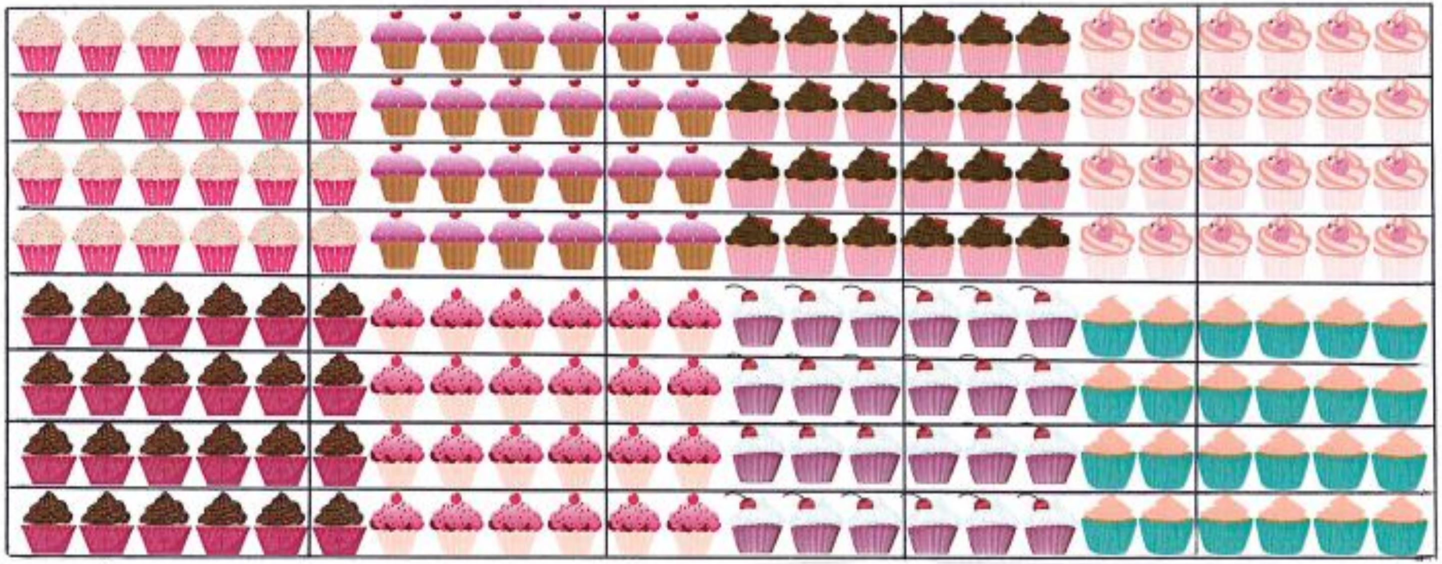




http://mentalfloss.com/article/28052/10-funny-and-fabulous-flowcharts

$5+5+5+5+5+5+5+5+5+5+5+5+5+5+5+5+5+5+5+$
$5+5+5+5+5+5+5+5+5+5+5+5+5=160$

$160+32=192$



$4+$
$4+$
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$4+$
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$4+$
$4=32$

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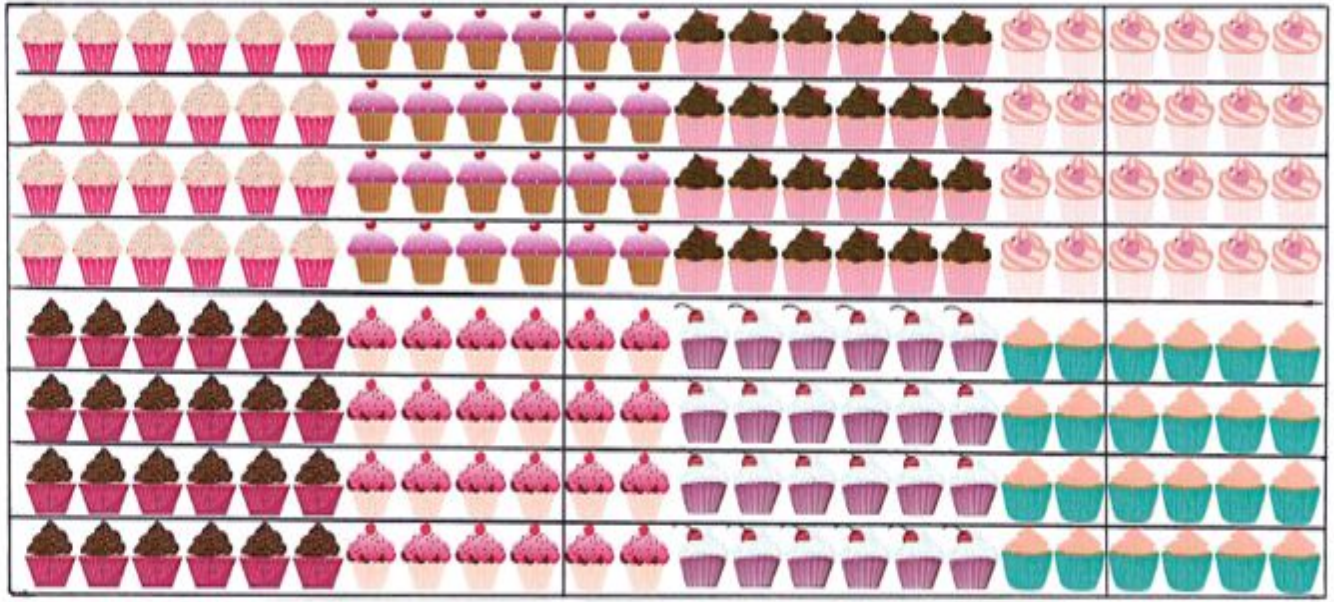
160 + 32 = 192



4 +
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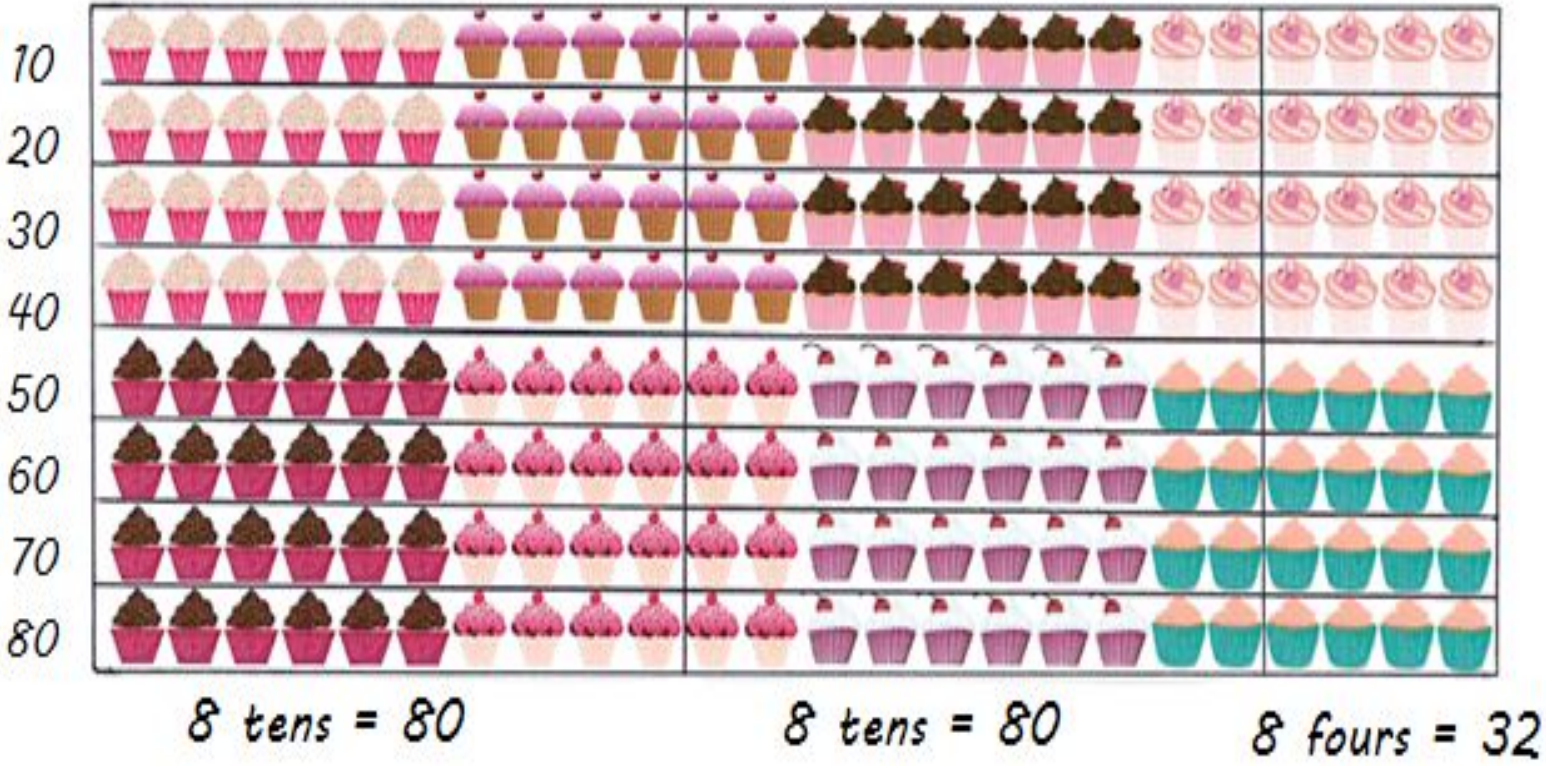
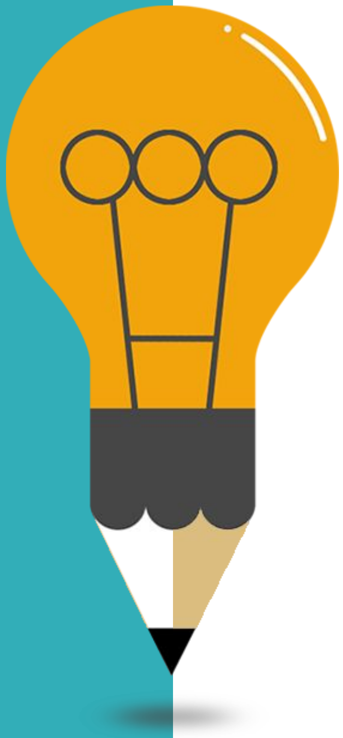
4 = 32


10
20
30
40
50
60
70
80
8 tens = 80
8 tens = 80
8 fours = 32

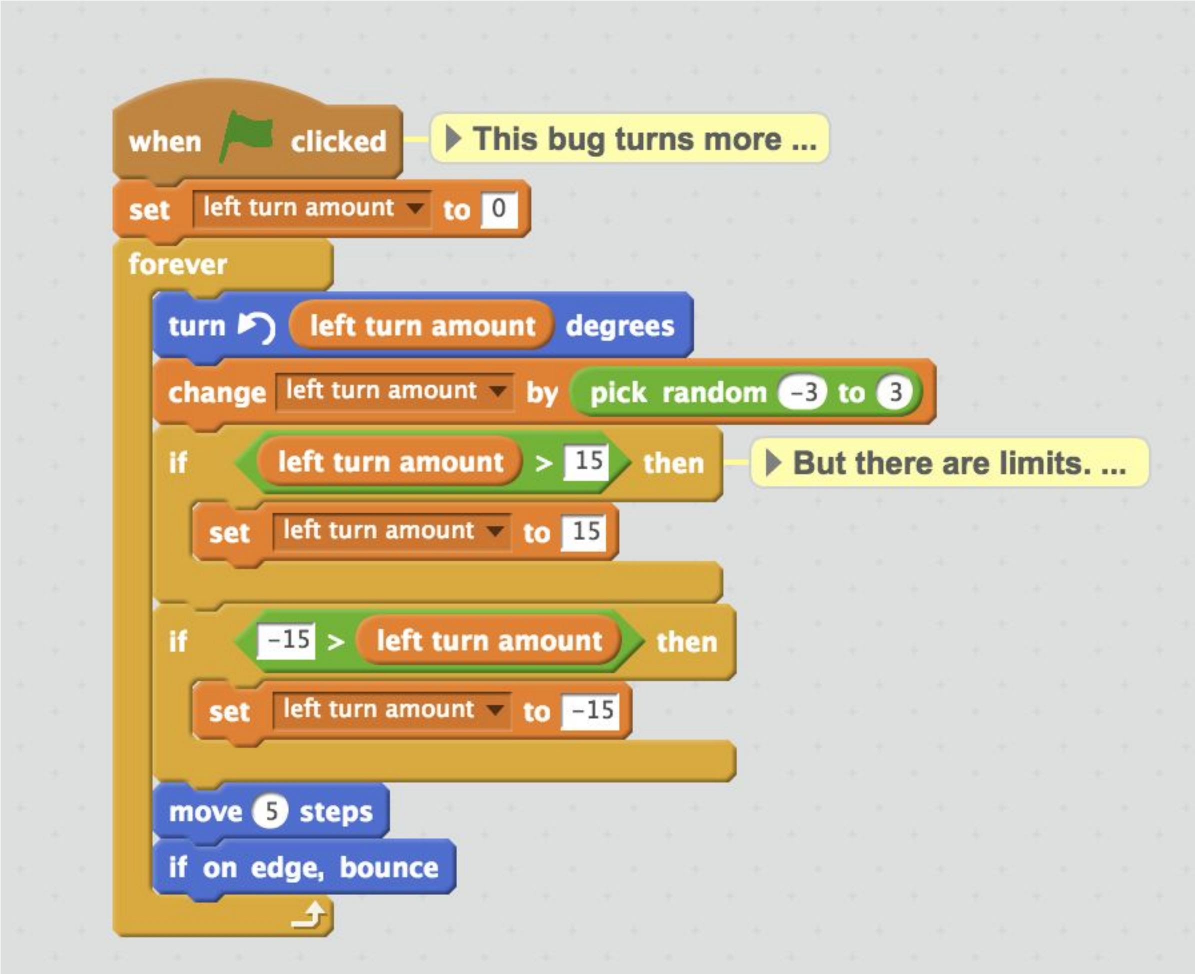


Fixing the Odds

You have two bags, four red balls and four white balls. You must put all the balls in the bags although you are allowed to have one bag empty.

How should you distribute the balls between the two bags so as to make the probability of choosing a red ball as small as possible and what will the probability be in that case?

https://scratch.mit.edu/projects/53219390/#editor



https://scratch.mit.edu/projects/53219390/#editor

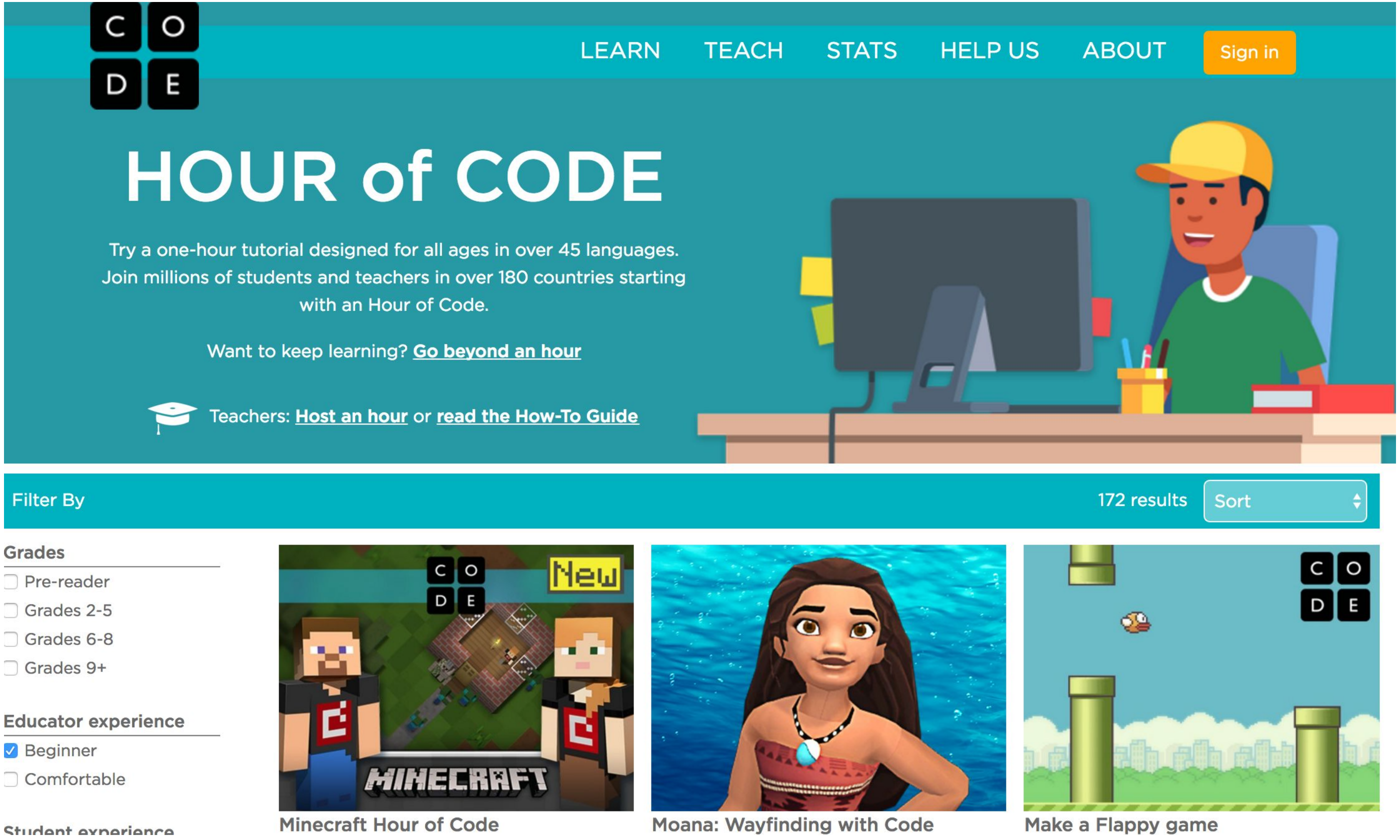
Hour of Code

https://code.org/learn

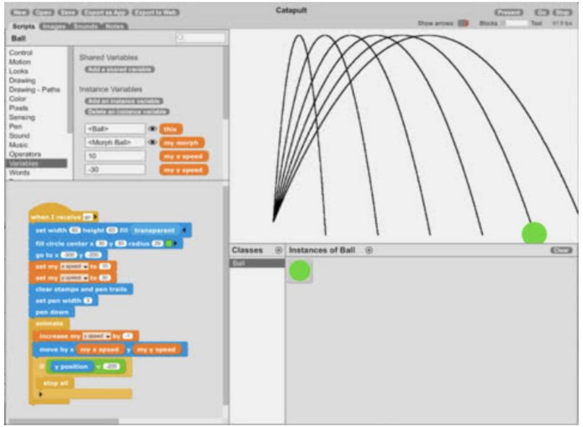
More girls tried computer science than in the last 70 years

Diversity of students in our courses

Code.org increases diversity in computer science by reaching students of all backgrounds where they are — at their skill-level, in their schools, and in ways that inspire them to keep learning. Read about **our efforts to increase diversity in computer science**.



https://hourofcode.com/au/learn?grade=6-8&subject=math



Build a Catapult

GP Blocks

Grades 6+ | Blocks

Participants will build a catapult to launch a ball from one side of the stage to the other, as in the game Angry Birds.

Start

More resources	Teacher notes
Short link	https://hourofcode.com/gpbcatapult
Student experience	Comfortable
Classroom technology	All modern browsers
Topics	Math, Science
Activity type	Self-led tutorial
Length	One hour
Languages	English only

http://gpblocks.org/hourOfCode2017b/

Data Generation

Using Sphero robots and coding

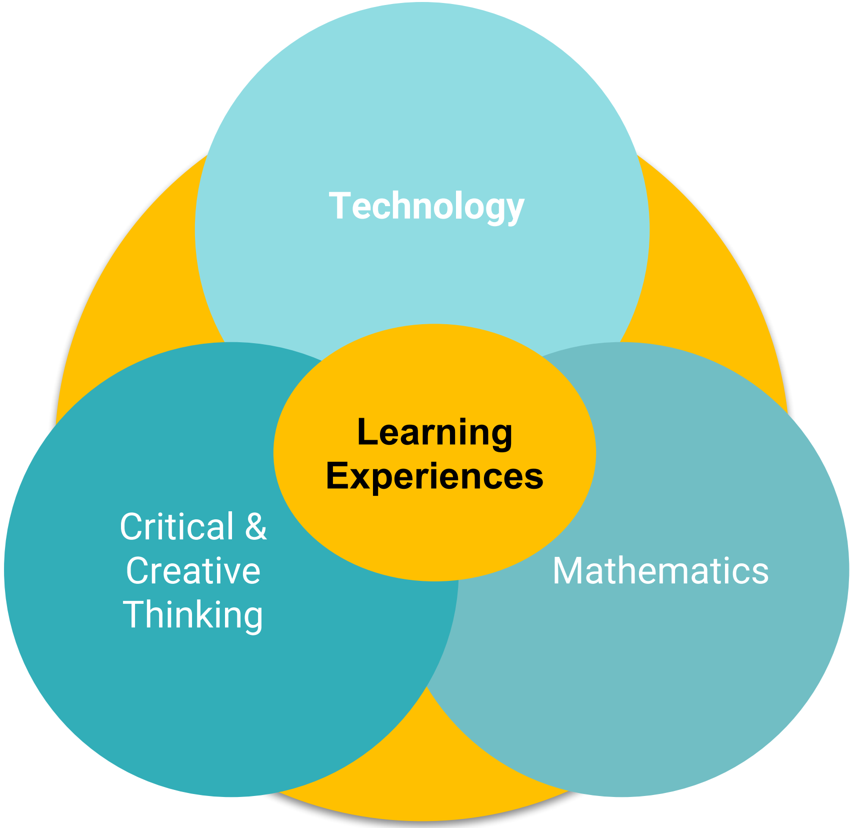
Mathematics – Data, Measurement, Mean, Median & Mode.

Skills students develop:

- Coding using block code
- Percentages, Angles, Measurement, Time, Distance, Speed
- Data, Analysing data, Mean, Median & Mode

https://youtu.be/4IlaGeNfVYg. (5sec)

https://elenikyritsis.com/2016/08/20/spheros-in-the-classroom/


Technology
Learning Experiences
Critical & Creative Thinking
Mathematics

Critical and Creative Thinking learning continuum

Sub-element	Level 1 Typically, by the end of Foundation Year, students:	Level 2 Typically, by the end of Year 2, students:	Level 3 Typically, by the end of Year 4, students:	Level 4 Typically, by the end of Year 6, students:	Level 5 Typically, by the end of Year 8, students:	Level 6 Typically, by the end of Year 10, students:
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Pose questions	pose factual and exploratory questions based on personal interests and experiences	pose questions to identify and clarify issues, and compare information in their world	pose questions to expand their knowledge about the world	pose questions to clarify and interpret information and probe for causes and consequences	pose questions to probe assumptions and investigate complex issues	pose questions to critically analyse complex issues and abstract ideas
Identify and clarify information and ideas	identify and describe familiar information and ideas during a discussion or investigation	identify and explore information and ideas from source materials	identify main ideas and select and clarify information from a range of sources	identify and clarify relevant information and prioritise ideas	clarify information and ideas from texts or images when exploring challenging issues	clarify complex information and ideas drawn from a range of sources
Organise and process information	gather similar information or depictions from given sources	organise information based on similar or relevant ideas from several sources	collect, compare and categorise facts and opinions found in a widening range of sources	analyse, condense and combine relevant information from multiple sources	critically analyse information and evidence according to criteria such as validity and relevance	critically analyse independently sourced information to determine bias and reliability
Generating ideas, possibilities and actions element						
Imagine possibilities and connect ideas	use imagination to view or create things in new ways and connect two things that seem different	build on what they know to create ideas and possibilities in ways that are new to them	expand on known ideas to create new and imaginative combinations	combine ideas in a variety of ways and from a range of sources to create new possibilities	draw parallels between known and new ideas to create new ways of achieving goals	create and connect complex ideas using imagery, analogies and symbolism
Consider alternatives	suggest alternative and creative ways to approach a given situation or task	identify and compare creative ideas to think broadly about a given situation or problem	explore situations using creative thinking strategies to propose a range of alternatives	identify situations where current approaches do not work, challenge existing ideas and generate alternative solutions	generate alternatives and innovative solutions, and adapt ideas, including when information is limited or conflicting	speculate on creative options to modify ideas when circumstances change
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Organise & process information

Seek solutions and put ideas in action

Thinking about thinking

Apply logic and reasoning

Evaluate procedures & outcomes

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Reflect on processes	identify the main elements of the steps in a thinking process	outline the details and sequence in a whole task and separate it into workable parts	identify pertinent information in an investigation and separate into smaller parts or ideas	identify and justify the thinking behind choices they have made	evaluate and justify the reasons behind choosing a particular problem-solving strategy	balance rational and irrational components of a complex or ambiguous problem to evaluate evidence
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Analysing, synthesising and evaluating reasoning and procedures element						
Apply logic and reasoning	identify the thinking used to solve problems in given situations	identify reasoning used in choices or actions in specific situations	identify and apply appropriate reasoning and thinking strategies for particular outcomes	assess whether there is adequate reasoning and evidence to justify a claim, conclusion or outcome	identify gaps in reasoning and missing elements in information	analyse reasoning used in finding and applying solutions, and in choice of resources
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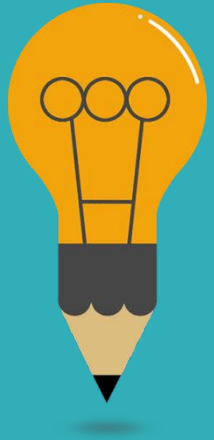
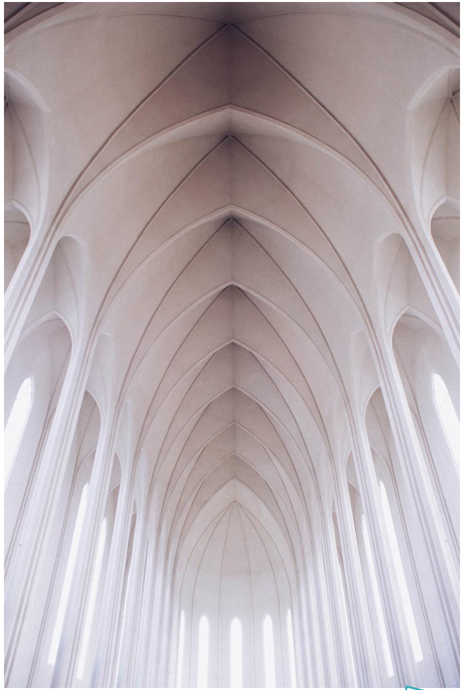
https://www.australiancurriculum.edu.au/media/1072/general-capabilities-creative-and-critical-thinking-learning-continuum.pdf

Low Floors with High Ceilings

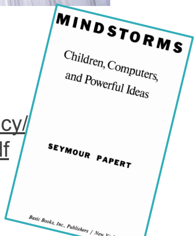


… supports differentiated learning …

Students can engage at their ability and comfort levels and investigate extensions as they develop conceptual understanding and gain confidence.



Seymour Papert, 1980
http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/Computer_Coding_K8_en.pdf



Virtual Reality, Machine Learning & Maths

Maths in the "real" world?

VR MATH

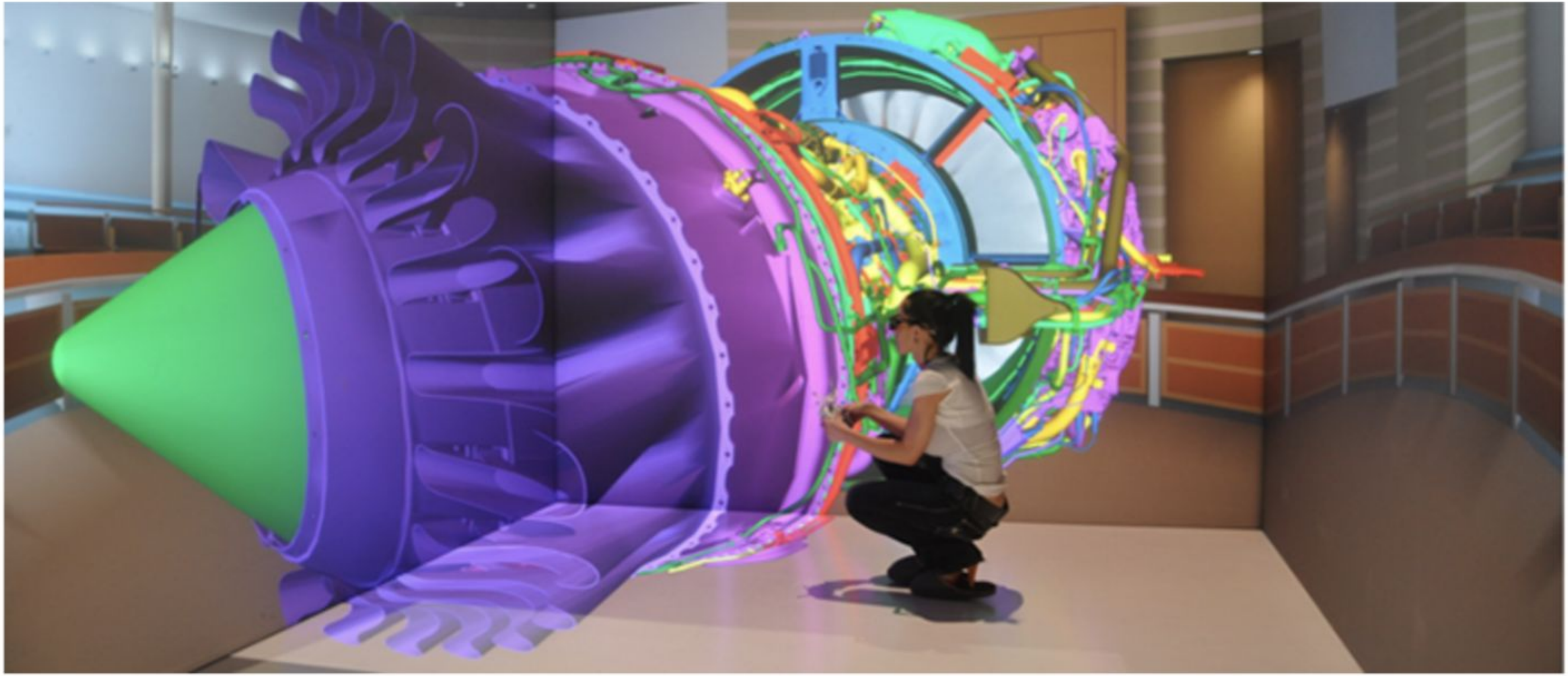
is an interactive educational application helping students understand 3D geometry, graphs and vectors - via Virtual and Augmented Reality.

https://vrmath.co/

Virtual Reality is *not* a future tool.

It is already in use in a range of fields:

1. Gaming – play, explore, build and interact inside games
2. Virtual museums - tour, view up close and talk to museum staff
3. Virtual theme parks – ride a theme park roller-coaster!
4. Theatre - immersive performances
5. History - visit' historic locations up close, participate in historic events (WW1, Australian settlement, Mabo land rights declaration)
6. Military – VR parachuting, flight simulation, battle simulation, boot camp, medic training
7. Real estate – VR house tours & building plans
8. Design - tour architects' designs, test ideas, explore full size models
9. Surgery - virtual practice, interaction with patients, robotic surgery, diagnoses
10. Universities - recruit students with virtual tours, meet with students
11. Emergency management - explore video footage to analyse risk in dangerous situations (aftermath of a tsunami or volcanic eruption)
12. Artists – collaborate with others remotely, walk through large scale art installations
13. Fashion - create virtual models, explore 3D views of designs
14. Start-ups - explore new products, design, plan for billboard advertising
15. Business - remote workers can benefit from virtual interactions with colleagues in VR (virtual meetings & virtual coffee breaks)
16. Sport – bring the audience on to the running track or into the pool, design and test running shoes, coach athletes in new skills, diagnose problems during a game (walk the MCG during a game), train at home with a virtual trainer
17. Shopping - Combine at-home Internet shopping with visiting items in store (also, soon you'll be able to 'touch' fabrics, hold items and talk to virtual staff (consider doing this at Bunnings, David Jones or Toys R Us!)
18. Instructional videos for repairs/DIY - rehearse your repair with an expert before performing it on your own.
19. Building – check plans for viability, ground works planning, simulated construction timing, testing of build plan (to increase efficiency)
20. Computer programming – use a virtual setting to physically move between algorithms and programs to test code. Next is "post-symbolic" coding that uses drawing as a method of writing program, these can then be manipulated in a VR environment to speed up coding and programming (Microsoft)
21. Environment - promote positive environmental practices by visiting locations before/after human impact
22. Virtual reality music (played on VR instruments), VR books (walk through the pages) and VR art (view art pieces alongside the artist, in the location that inspired the art)
23. MIT - collaborative learning environments, work with other students within the virtual space



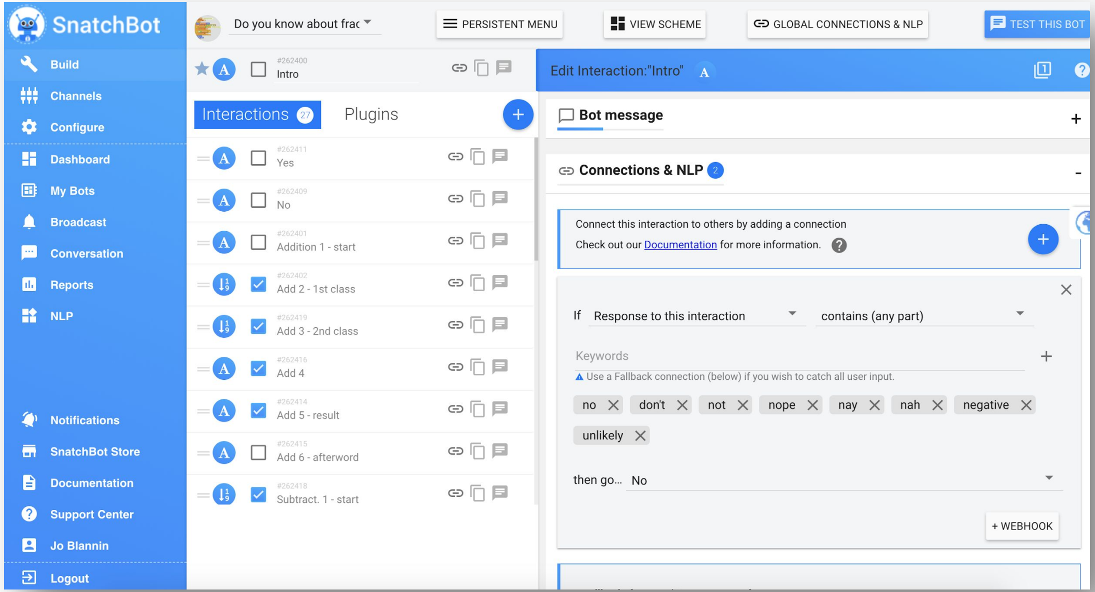
Showing mechanisms in 3D is extremely helpful in understanding how a system functions. Image credit: eonreality.

Problem-Solving with VR:

- What is the problem? What am I trying to figure out?
- What do I know?
- What do I need to know to solve the problem?
- What problems like this have I solved before?
- What solutions could work?
- What strategies will work best in this situation?

AI, Chatbots & Machine Learning

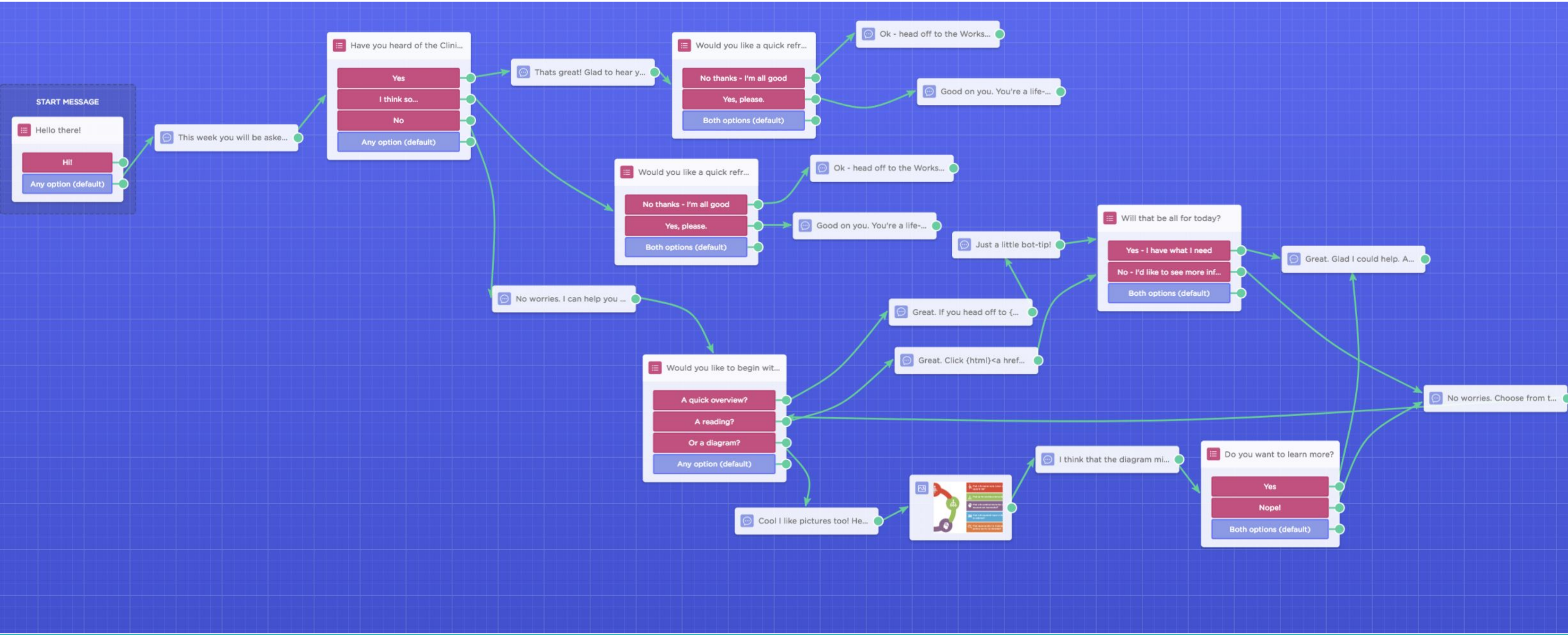
In 2016, Bill Gates announced that the Bill and Melissa Gates Foundation will invest more than $240 million dollars in a tech project that personalizes institutional learning

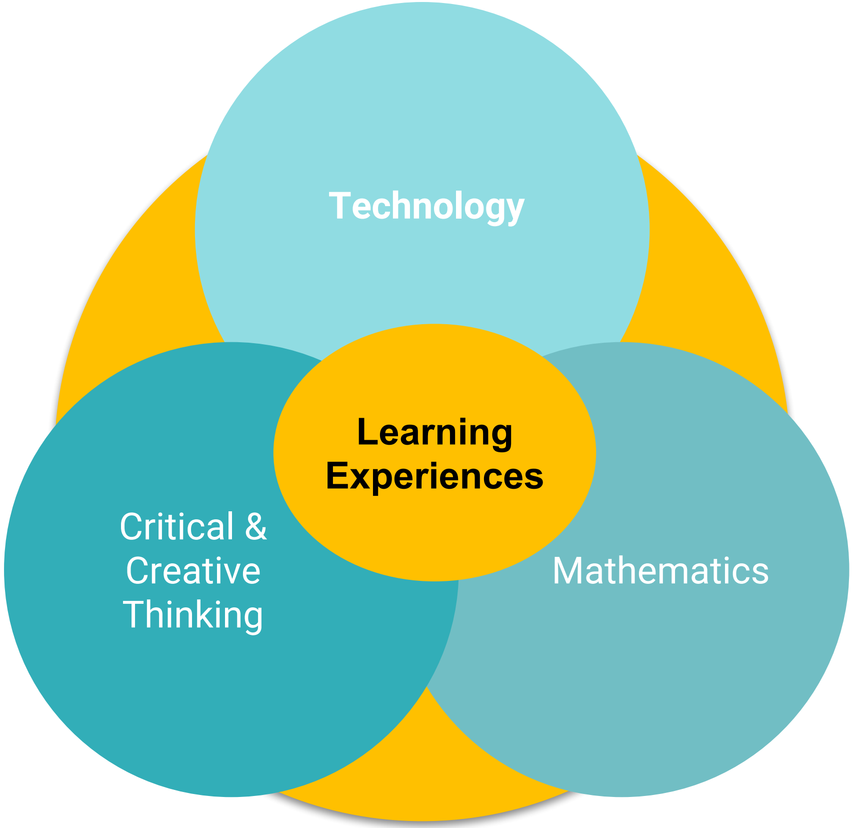


https://snatchbot.me/bot/19303/build

Behind the scenes

https://landbot.io/u/H-36651-BDJF8UUWWJ2SOJMQ/index.html




Technology
Learning Experiences
Critical & Creative Thinking
Mathematics

acara AUSTRALIAN CURRICULUM, ASSESSMENT AND REPORTING AUTHORITY — Australian CURRICULUM

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Identify and clarify information and ideas

Imagine possibilities and connect ideas

Transfer knowledge into new contents

Think about thinking (metacognition)

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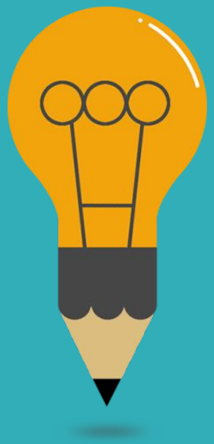
Technology for Mathematics learning

MENU



It's a skill. This is the 21st Century, it's (technology) equal to maths and electricity… ICT … yeah …

(Teacher A, Gregstone Primary School)

Findings: 5 Themes


Seeking equity for all students


Using multiple strategies for personal learning


Demonstrating risk-taking and continual learning


School leadership

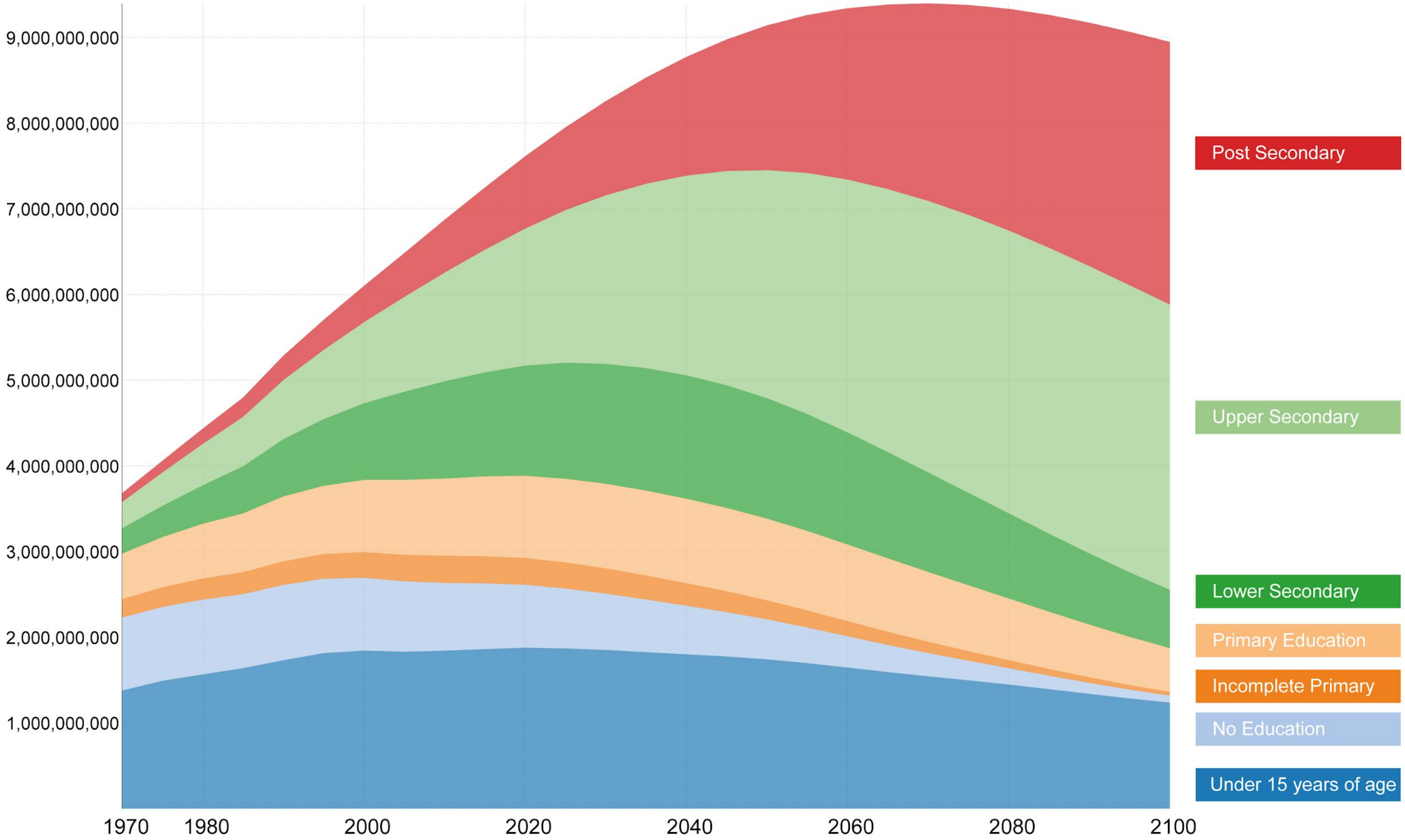

Student Learning

2018 This Is What Happens In An Internet Minute

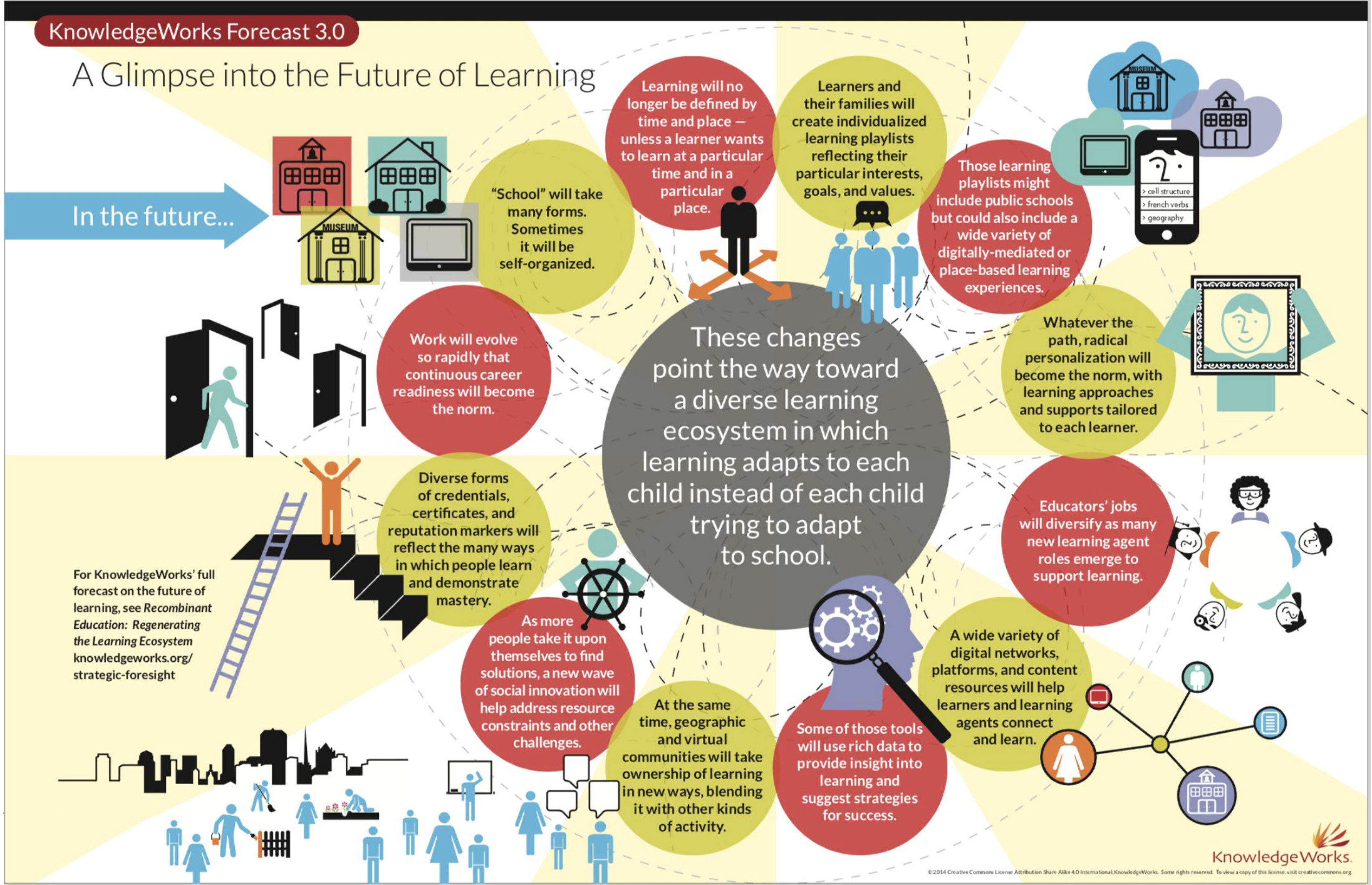
Projection of the World Population by Level of Education (1970 – 2100)

This visualization shows the Medium projection by the International Institute for Applied Systems Analysis (IIASA).
The researchers who created this projection describe it as their "middle of the road scenario that can also be seen as the most likely path".

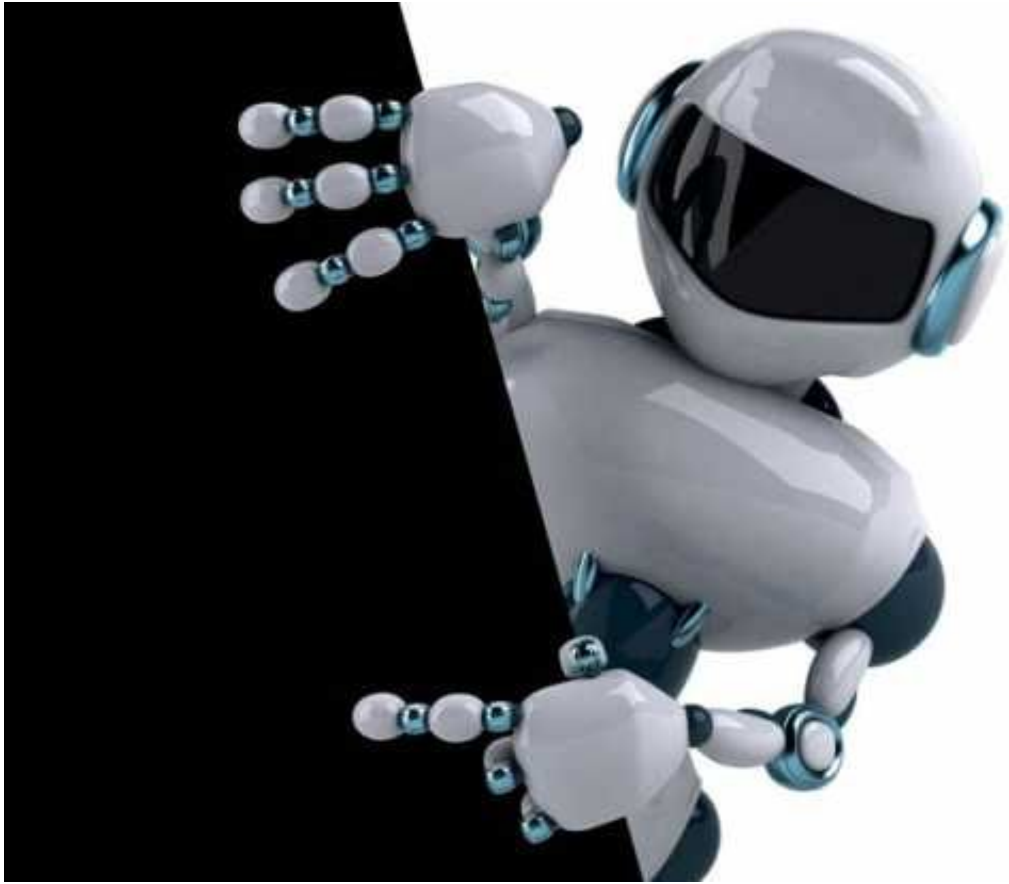
Our World in Data

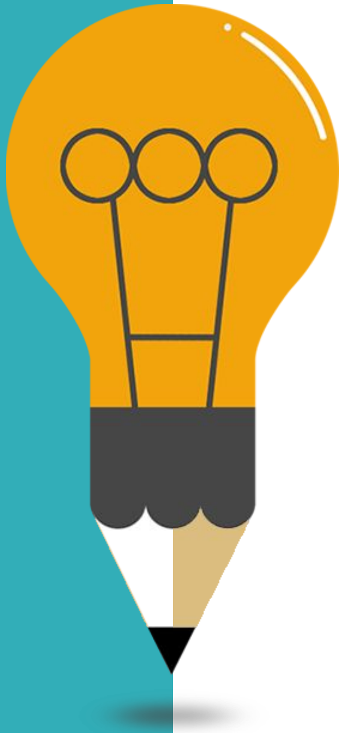


Data source: International Institute for Applied Systems Analysis (IIASA) (Global Projection – Medium SSP2)
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.



KnowledgeWorks Forecast 3.0
A Glimpse into the Future of Learning
In the future...
MUSEUM
"School" will take many forms. Sometimes it will be self-organized.
Learning will no longer be defined by time and place — unless a learner wants to learn at a particular time and in a particular place.
Learners and their families will create individualized learning playlists reflecting their particular interests, goals, and values.
Those learning playlists might include public schools but could also include a wide variety of digitally-mediated or place-based learning experiences.
MUSEUM
> cell structure
> french verbs
> geography
Work will evolve so rapidly that continuous career readiness will become the norm.
These changes point the way toward a diverse learning ecosystem in which learning adapts to each child instead of each child trying to adapt to school.
Whatever the path, radical personalization will become the norm, with learning approaches and supports tailored to each learner.
Diverse forms of credentials, certificates, and reputation markers will reflect the many ways in which people learn and demonstrate mastery.
Educators' jobs will diversify as many new learning agent roles emerge to support learning.
For KnowledgeWorks' full forecast on the future of learning, see *Recombinant Education: Regenerating the Learning Ecosystem* knowledgeworks.org/strategic-foresight
As more people take it upon themselves to find solutions, a new wave of social innovation will help address resource constraints and other challenges.
A wide variety of digital networks, platforms, and content resources will help learners and learning agents connect and learn.
At the same time, geographic and virtual communities will take ownership of learning in new ways, blending it with other kinds of activity.
Some of those tools will use rich data to provide insight into learning and suggest strategies for success.
KnowledgeWorks.
©2014 Creative Commons License Attribution Share Alike 4.0 International, KnowledgeWorks. Some rights reserved. To view a copy of this license, visit creativecommons.org





"There's **nothing magical** about any tech tool.

Real magic rests in the minds and hearts of **teachers** using digital tools to introduce students to **new individuals, ideas and opportunities**."

Ferriter

- http://www.vcaa.vic.edu.au/Pages/foundation10/viccurriculum/digitech/extresources.aspx
- https://www.iste.org/explore/articleDetail?articleid=152
- https://www.iste.org/explore/articleDetail?articleid=894&category=In-the-classroom&article=3+easy+lessons+that+teach+coding+and+computational+thinking
- http://www.iste.org/docs/ct-documents/ct-teacher-resources_2ed-pdf.pdf?sfvrsn=2
- www.code.org