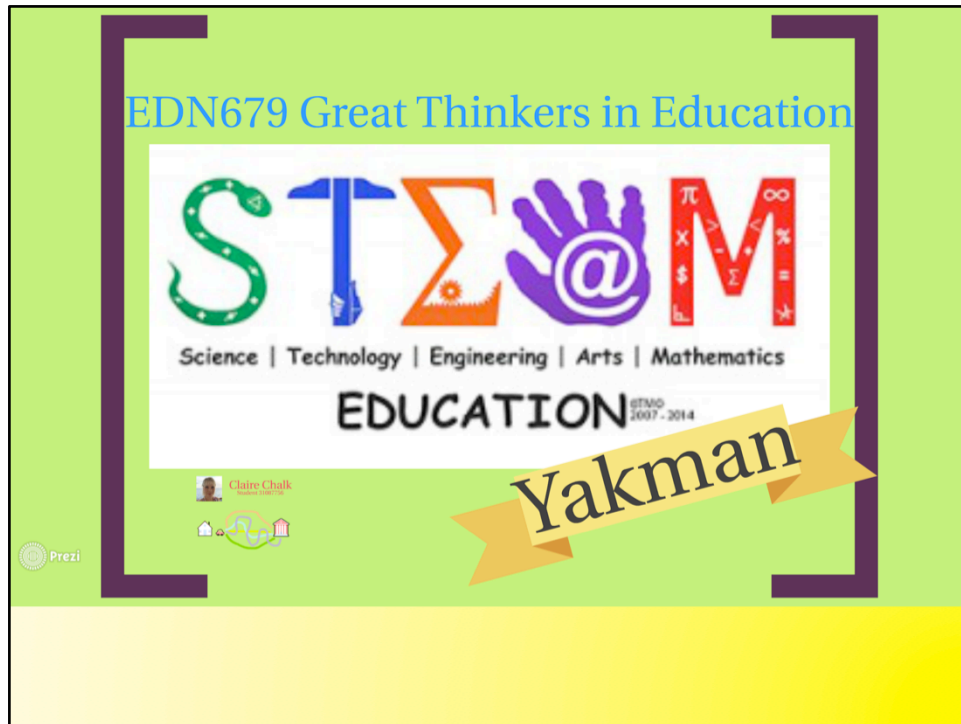




Hello and welcome to the last presentation on a seminal thinker in education for our unit EDN679. We have covered a lot this semester, and I believe that whilst you listen to, read, and watch this presentation you will, like I have, make connections to many of the scholars we have researched this semester.



Today's topic is STEAM: Science, Technology, Engineering, Arts and Mathematics. Our theorist is Yakman.



My name is Claire Chalk, and for today's presentation I would like you to essentially *bear with me*. I had multiple ideas as to how to present the information in this session: Think of it as which path you would take to drive to the bank. You have multiple paths to choose from – I thought the yellow path would be boring today so we are taking every other colour path instead. I ask you to learn first, then think and be critical.



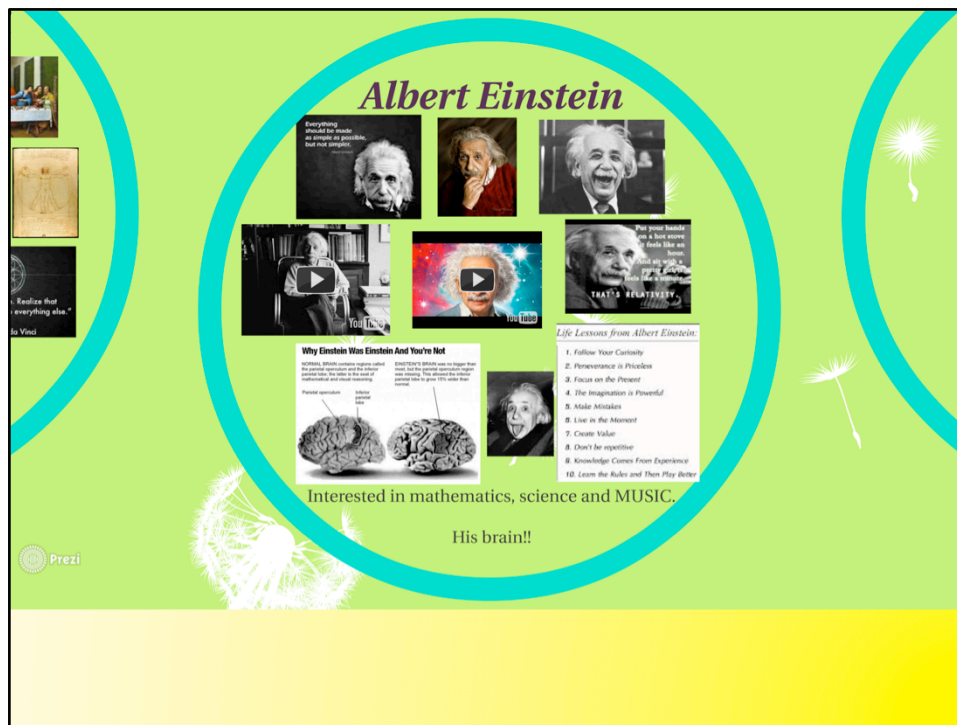
Leonardo da Vinci, Albert Einstein, and Steve Jobs. Not an extensive list, no, not at all. But these three men have all made remarkable contributions to contemporary society, may have at one point (or more!) being told 'no', and who have in some way being 'ahead of their time'.

*Leonardo da Vinci*

da Vinci is known as an 'typical'  
Renaissance man: he was a scientist,  
mathematician, engineer, inventor,  
anatomist, painter, sculptor, architect,  
botanist, musician, writer...

Prezi

Our friend Leo (that's da Vinci not DiCaprio!), he is often one of the first people thought of and attached to the Renaissance period. Not only was he an artist and inventor, but an anatomist (this is why his depictions of humans are so accurate!), mathematician, engineer, and a MUSICIAN! There's two videos here that are quite short, and well worth watching.



Albert. (Now is it bad of me to admit that I have a bit of an academic crush on him – oh I’m blushing at the sight!). My dear friend Albert, most known for the theory of relativity (don’t you love his quote when asked to describe relativity?), but in 1905 he innovated on an idea from 1827 (Brownian motion), settled the argument for ‘why is the sky blue’, won the Nobel Prize and his theories laid the foundation for the atomic bomb! Little more known, was that he was a talented musician. Again, I highly recommend the two videos embedded – especially the one about his brain – oh okay, but very quick.... After he died his brain was removed and studied. Researchers discovered anomalies such as increased glial cells (neurological garbage collectors that clean up the brain’s mess from neurons firing)? A thinner and densely packed frontal cortex? An absent Sylvian fissure (a divider of sorts meaning that the parietal lobe was 15% wider)? The idea being that this contributed to his genius.

And I have to share... the infamous picture of him poking his tongue out – he did this to reporters!

I have to move on...!



Steve Jobs – well there is ample evidence of his apple empire in my home: I have the Macbook, apple watch, two iPads, an iPhone, and soon to be delivered is my new iMac. I include Steve here primarily because he is an innovator, a leader and a risk taker. I love his 'to the crazy ones' advertising (check out the video on the bottom left), and his story of 'connecting the dots' (video bottom right).

He was brave, just like Albert and Leo, and together these three men represent common traits.



They used the principles of STEAM in their daily practice!

That's science, technology, engineering, arts and mathematics.

Reflect: Do you think that this contributed to their enduring success?

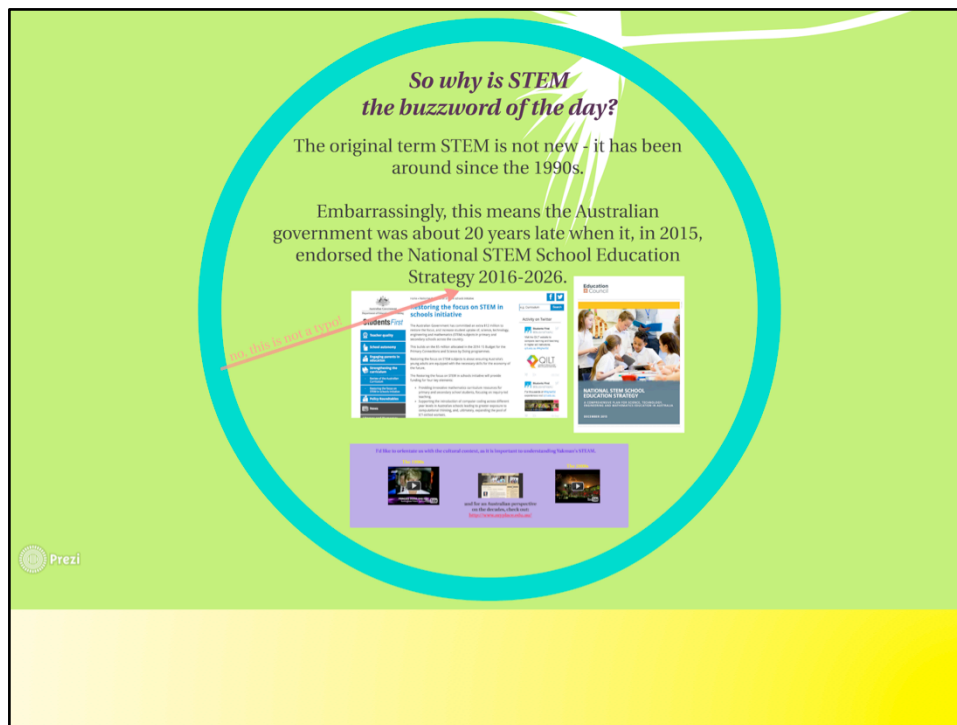




To orient ourselves with the cultural context of the 1990s and 2000s, watch the montage videos and have a quick read through the *My Place* website (as a side note this is a fantastic resource!).

But briefly... Once upon a time, in a century long ago (let's call it the 1990s): Paul Keating was Australia's PM, then followed by John Howard, the debate for Australia to become a republic started to grow, the internet and mobile phone became more accessible, there was the recession in the early part of the decade, women in the ADF were finally permitted to take part in combat-related duties, The Wiggles started performing, and let's not forget the movies *Priscilla* and *Muriel's Wedding!*

Then the 2000s (the not too distant past): Sydney hosted the 2000 Commonwealth Olympic games and we were all cursing Nikki Webster for her song *Strawberry Kisses* (totally normal to be singing this on repeat in our heads – wasn't it!?). Australia celebrated its centenary of Federation, and on 1 July 2000 the GST was introduced (replacing the Wholesale Sales Tax). The Howard government introduced the 'Pacific Solution' and then in August 2001 the World Trade Centre and Pentagon was hit in terror attacks and the *War on Terror* commenced. In this decade private internet usage skyrocketed, and social networking sites and YouTube started. In 2009 Dr John O'Sullivan was one of two recipients to be awarded the PM's Prize for Science, for leading a CSIRO team to solve a multipath problem in information networks – the result now being fast wireless networks.

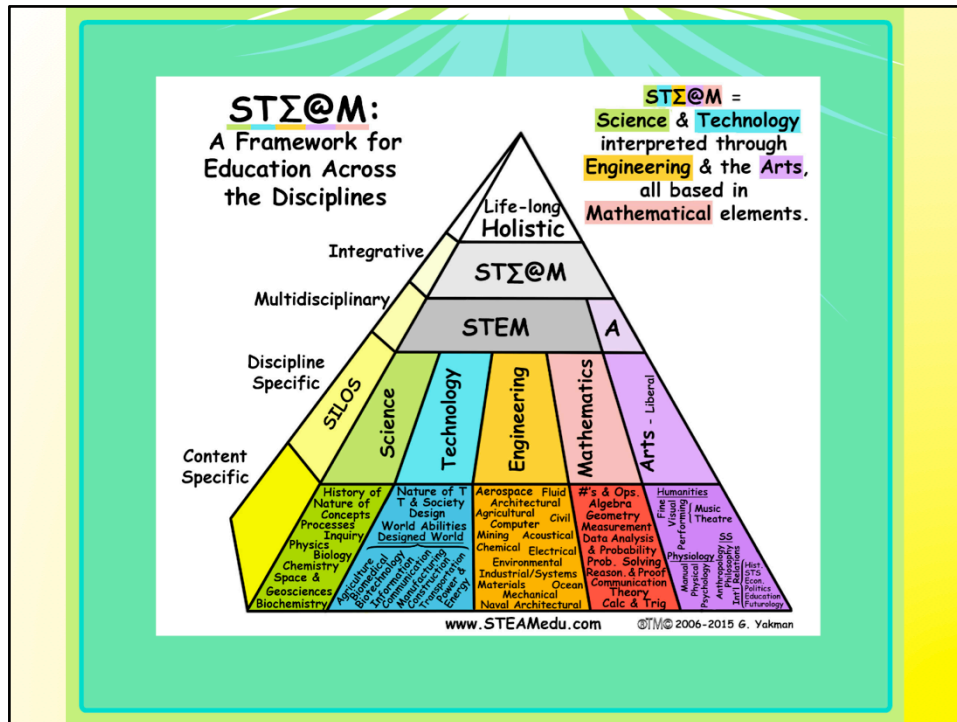


So back to STEAM (and STEM)... I need to you be clear on something about the current buzzword STEM. It has been around since the 1990s!!

So shouldn't it shock you that it was only in December 2015 that the Australian Education Ministers endorsed the National STEM School Education Strategy 2016-2026? A 10 year plan for the future, created 20 years late!?



We are going to talk more about STEM and STEAM in a moment, but I felt it was necessary for you to understand this now in order to situate your understanding of the debate a little better, and also for when I introduce you to Yakman.



In Australia our mandated National Curriculum, a document that had its initial release in 2010, describes the skills and attributes students will need to live, work and succeed within contemporary society. These are 21<sup>st</sup> century skills (yet again another buzz word).

Enter: STEAM. This STEAM pyramid, created by Yakman (who you will meet shortly), is what ‘all the fuss’ is about.

It has the 1990s STEM principles of science, technology, engineering and maths. But it also includes liberal arts – of humanities and physiology. We will delve deeper into this pyramid later because I get a feeling that perhaps you’re a little uncomfortable including arts...

But while we’re here, and to ground your contextual knowledge, let’s also give Murdoch Uni a shout out! Click on the link to view 😊 (I confess I only came across this website by accident).

• STEAM education is not in opposition to STEM education; it enriches and expands the scope of STEM education.

• STEAM education is a curriculum philosophy that empowers science teachers to engage in school-based curriculum development.

• STEAM education involves teachers in developing a humanistic vision of 21st century education and their role as professionals.

• STEAM education provides a creative design space for teachers in different learning areas to collaborate in developing integrated curricula.

• STEAM education on a modest scale can be designed and implemented by an individual innovative teacher.

From Professor Peter Charles Taylor @ Murdoch Uni. You will see the reference for his paper in the reference list.

AND Murdoch are not the only people to know STEAM is vital to the success of our 21st century learners...

**Abstract:** Studies have found little correlation between creativity and being gifted or talented, but do show that creative people are more broadly trained, have more avocational interests, and display more ability in these interests than the average person. In the sciences, technology, engineering and mathematics (STEM) fields, the avocational interests of the most successful professionals are unusually likely to involve fine arts such as painting or music; literary accomplishments; or crafts such as wood-working and metalworking, mechanics and electronics. Four types of evidence are brought together in this review to explore why such avocations might stimulate the creative capacity of STEM professionals. First, STEM professionals themselves argue that beyond verbal and mathematical skill, success requires a vivid visual and spatial imagination; hand-eye coordination and manipulative ability; skill with making and interpreting models; and a highly developed aesthetic or artistic sensibility. Second, controlled statistical studies of large groups (hundreds to thousands) of STEM professionals reveal strong correlations between artistic, musical, literary and crafts activities and measures of success in STEM subjects such as Nobel Prizes, numbers of patents or companies founded. Third, STEM professionals involved in these statistical studies themselves can describe specific ways in which their avocations stimulate their vocational successes. And fourth, many of these specific stimuli (such as improved observational and visual thinking skills, manipulative skills

and tool use, and improved learning and retention strategies) also improve STEM learning in well-controlled classroom trials. The knowledge and skills required to be professionally creative are, in short, learnable.

**Keywords:** Polymathy · Creativity · Spatial imagination · Manipulative skill · Music · Entrepreneurship

**Introduction: the problematic relationship between giftedness and creativity**

Around 1925, the adolescent Luis Walter Alvarez had two interesting experiences. One was to be tested as part of the cohort of brilliant young men and women that Stanford psychology professor Lewis Terman was recruiting to determine to what extent IQ determined creativity and life-time success. Luis also had discussions with his father, the renowned physician and physiologist Walter Alvarez, M.D., about whether to enroll in the local academic high school or the nearby trade tech school. Both experiences are instructive with regard to how best to train gifted and talented students today for the highest levels success in science, technology, engineering and mathematics (STEM) disciplines, for the young Alvarez would win a Nobel Prize in Physics in 1968 (Alvarez 1987).

Surprisingly, young Alvarez failed to meet the cutoff criterion of a 140 IQ to gain admission to the Terman study (the mean IQ of those who did participate was 151) (Ter-

I'm not going to read these out to you – that would be boring and you'd fall asleep (besides I don't have the time).

The crux of the articles is that adding the arts into STEM is fabulous and wonderful because students need the creativity and research over time demonstrates inspired minds have been artistically inclined (think about Leonardo, Albert and Steve).



So a quick recap because I'm sure your mind is jumbling and you're thinking what about STEM and STEAM and this person Yakman??

Point One: Leonardo, Albert and Steve CHANGED THE WORLD using STEAM principles.

Point Two: The term STEM was coined in 1990s – over 20 years ago.

Point Three: We've been introduced to STEAM: the focus whereby Science and Technology are interpreted through Engineering and the Arts, all based in Mathematical elements.

So where to now?



It's time to meet Yakman and unpack STEAM further.



Have a think about the thinkers we have met this semester and now consider the assumptions you most likely have made about Yakman.

Q: Is G. Yakman male or female?

Q: Is G. Yakman young or old?

Q: Is G. Yakman an inventor or innovator?



## *Georgette Yakman*



She is female.

She is young.

She is an innovator.

**Biography**

- Raised by Puerto Rican grandparents in upstate New York
  - Grandfather an engineer
  - Grandmother a homemaker with 'humanistic mindset'
- Mother and brother has aspergers
- Mother at one point married an artist, and Georgette had engineering influence of grandfather and art influence of stepfather

Prezi


YouTube

You're real  
You're going to

Georgette was raised by her Puerto Rican grandparents in upstate New York.

I highly recommend the video in this clip. Georgette recounts her childhood and early professional life, specifically the story of the lead up in events to her creating STEAM. I feel her story highlights to us as educators the necessity of being a reflective practitioner and that we do have the power to make a difference and effect change if it is based upon evidence.

At the age of 12, Georgette and her Grandfather designed and built this house. On completion of the work, what did her Grandfather say to her?

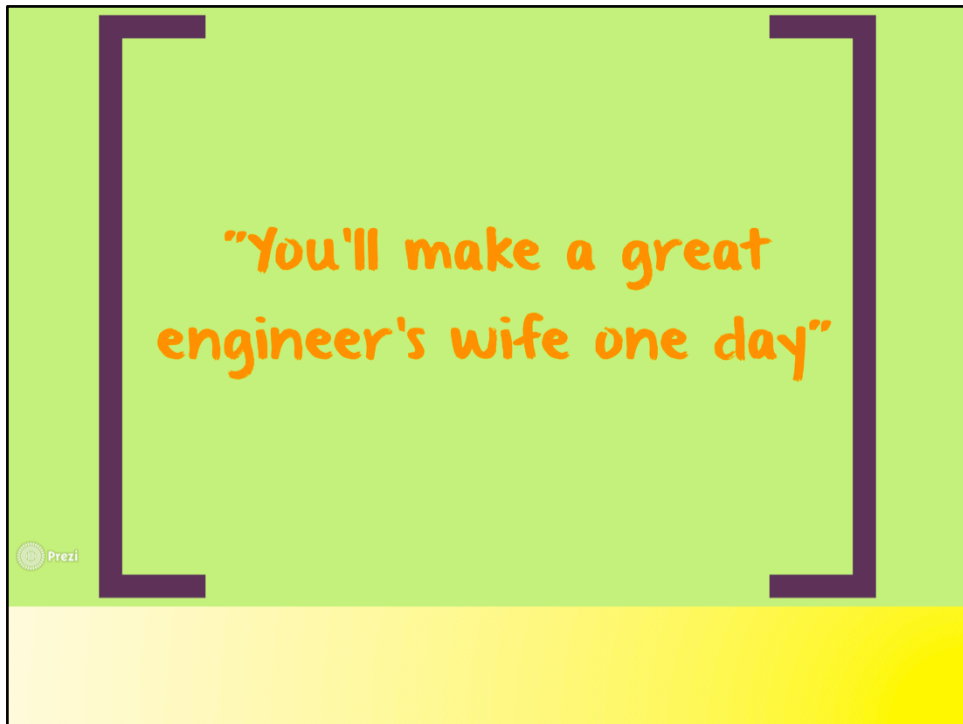


**"You're really smart.  
You're going to make a great...?"**

- *construction worker?*
- *engineer?*
- *architect?*
- *house proud home owner?*
- *artist?*
- *something else?*

Prezi

At the age of 12 Georgette and her grandfather designed and built this house – the only help they had was from a concrete layer. On completion of the work, her grandfather said to her “You’re really smart. You’re going to make a great construction worker? Engineer? Architect? House proud home owner? Artist?”



"You'll make a great engineer's wife one day."

I get the feeling he wasn't being offensive and that she wasn't offended – he was just espousing his cultural and personal beliefs.

**Biography**

- Raised by Puerto Rican grandparents in upstate New York
  - Grandfather an engineer
  - Grandmother a homemaker with 'humanistic mindset'
- Mother and brother has aspergers
- Mother at one point married an artist, and Georgette had engineering influence of grandfather and art influence of stepfather

YouTube

"You're really smart. You're going to make a great...!"

Prezi

Regardless of intentions, Georgette took the high road, confident in her feminist beliefs, and set out to be more.

oft

**STEAM**  
 Science | Technology | Engineering | Arts | Mathematics  
 EDUCATION 2014

[Developed STEAM Framework]      [Keynote at US Conference (A&M Aggie STEAM Conference)]      [Keynote at Shanghai Forum on STEAM Literacy in China]

2000      2007      2010      2011      2014      2015

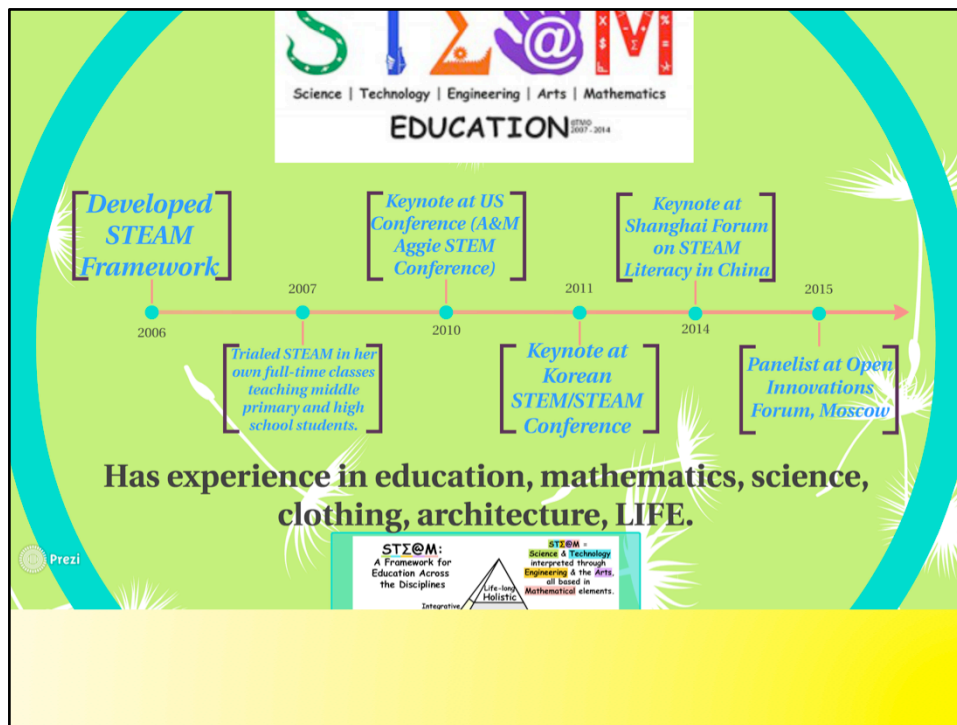
[Trained STEAM in her own full-time classes teaching middle-primary and high school students]      [Keynote at Korean STEAMSTEAM Conference]      [Panelist at Open Innovations Forum, Moscow]

**Has experience in education, mathematics, science, clothing, architecture, LIFE.**

**STEAM**  
 Science | Technology | Engineering | Arts | Mathematics

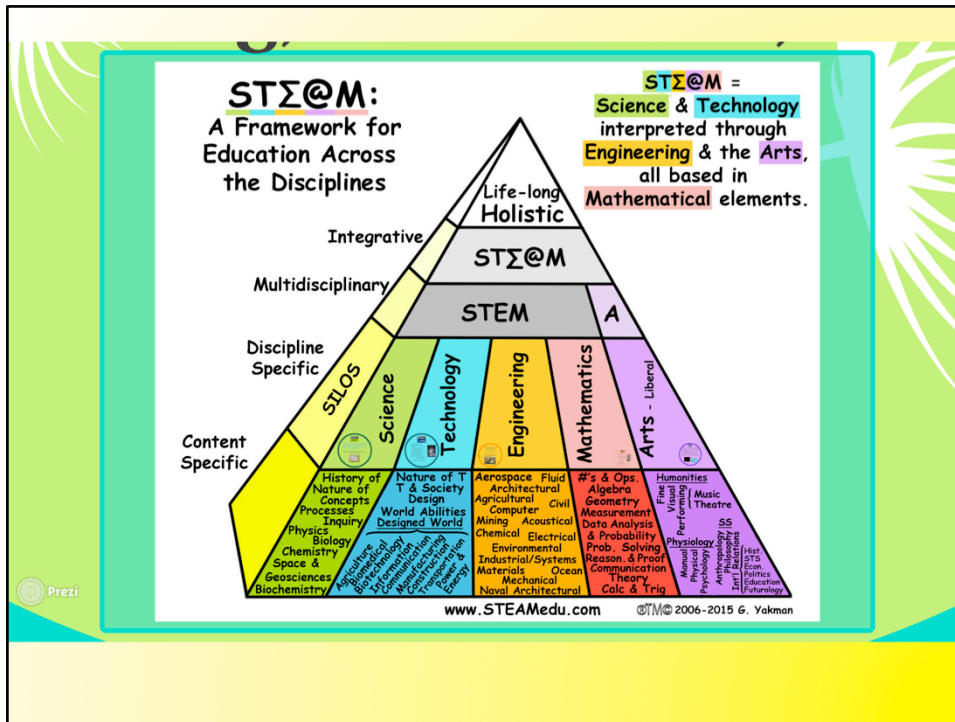
Prezi

She created STEAM. But how? What led her to this point?



Watching Georgette’s video you would know she is a highly educated woman – Bachelor degree, Masters degree in curriculum and instruction – technology education: STEM and a graduate certificate in integrative STEM education.

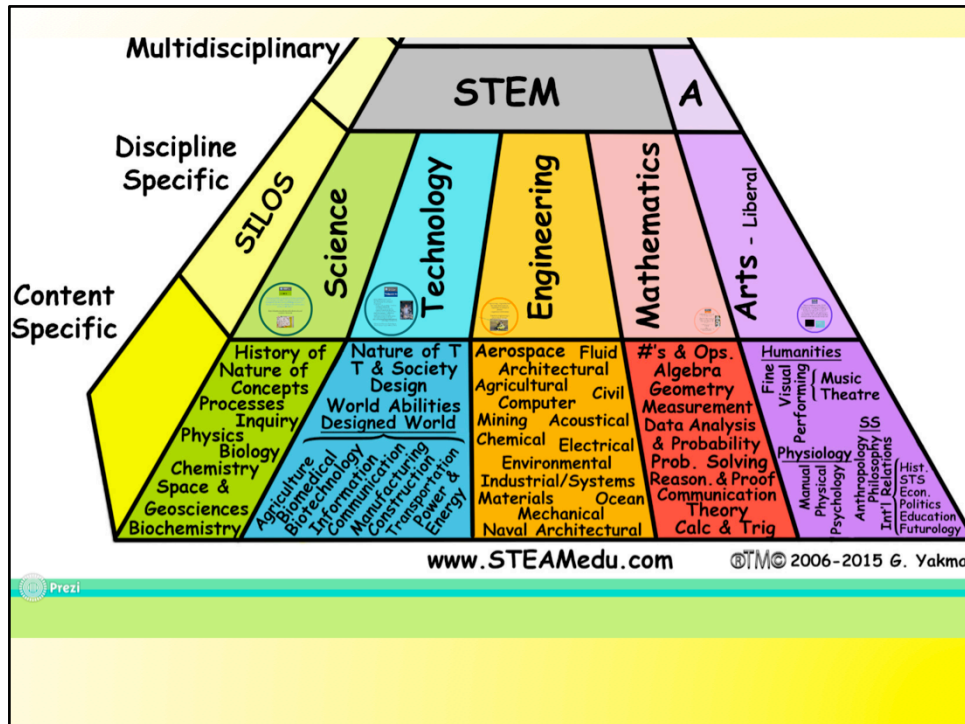
This gives weight to how and why she developed STEAM in 2006. Essentially she saw that there was more to STEM than STEM. In order for STEM to be successful, one needs art. She developed STEAM in 2006, trialed it **in her own classes** in 2007, and then it took off! She started presenting as keynotes at international conferences and the project has evolved.



You see at the tip of the pyramid that STEAM learning fosters life-long holistic learning – this is actually a key point in Australia’s National Curriculum...

You see that STEAM is integrative, compared to STEM which is multidisciplinary.





This STEAM pyramid shows how STEM and STEAM differ, and we are going to now briefly cover each element, spending most of our time on A – Arts.

Australian CURRICULUM

Science

"Science provides an empirical way of answering interesting and important questions about the biological, physical and technological world. [...] Science is a dynamic, collaborative and creative human endeavour"

<http://www.australiancurriculum.edu.au/science/rationale>

I heard that Oxygen and Magnesium were going out and I was like

O Mg

Prezi

Science is fun and engaging, and relevant to the world within which we live.

Oh, and because I am a bit of a self-confessed nerdy-geek you'll have to excuse the jokes!

**AC** Australian CURRICULUM

## Technologies

- IS NOT RESTRICTED TO ICT!!
- The Technology learning area, as described by AC, has two distinct components:
  - Design and Technologies: "students use design thinking and technologies to generate and produce designed solutions for authentic needs and opportunities."
  - Digital Technologies: "students use computational thinking and information systems to define, design and implement digital solutions."

<http://www.australiancurriculum.edu.au/technologies/introduction>

• Yakman herself describes Technology as "what is human-made" (Yakman, 2016).

20 years later and all of these things fit in your pocket.

Prezi

Technologies – something covered by the AC by two components:

- 1 – design and technologies
- 2 – digital technologies

These are two but similar things, and it is important to note technology is NOT RESTRICTED TO ICT!

engineering + ingenuity have  
the same latin roots as:

- ingeniare (to design or  
devise)
- ingenium (cleverness)

Therefore, engineering is  
about clever design.

*and in real life Rowan actually had a PhD in Engineering!*



Prezi

Engineering.

Believe it or not Rowan Atkinson actually attained a PhD in Engineering – but pursued comedy. In watching Mr Bean you see many pieces of evidence of CLEVER DESIGN!

 Australian CURRICULUM

**Mathematics**

“Mathematics has its own value and beauty” and mathematics ideas are “constantly developing.”

“Digital technologies are facilitating this expansion of ideas and providing access to new tools for continuing mathematical exploration and invention.”


Mathematics is vital to other disciplines.


<http://www.australiancurriculum.edu.au/mathematics/rationale>




 Prezi

Maths. Seriously. Who cannot love maths?

  
**The Arts**  
 Yakman explains Arts in STEAM incorporates “sharing knowledge with language arts; a working knowledge of manual and physical arts; better understanding the past and present through fine arts; and understanding developments with social/liberal arts.”

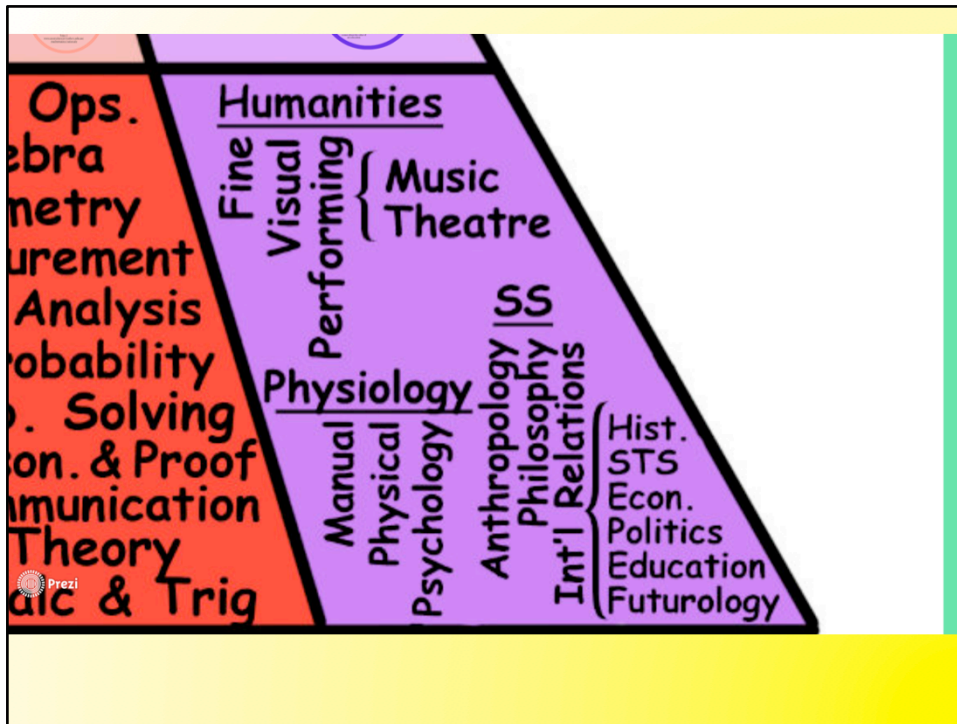
  
 Listen to Cindy Foley reason about the value of art education



Prezi

Which leads us to Art. In STEAM, the A is for liberal arts.

The AC explains there are five areas: drama, dance, media, music, and visual. But then when Yakman describes the social and liberal arts... she means humanities.



Let's have a look.

**But why do we need the A?**


Georgette says: "what and how you can perform processes with elements and materials, STEAM includes who and why those things are done and also a means by which to convey deeper level understandings of things beyond the base language of mathematics" (<http://steamedu.com/stem-to-steam-critical-article-and-steam-founders-g-yakmans-response/>)

Children who participate in art programs are four times more likely to have increased academic achievement (Martin, 2014).

**It's not an approach where students are accelerated. It is an approach where students are STRETCHED (Normington, 2016).**

Cindy says it's about developing students' capacity to think creatively and make connections, to teach for creativity, which means being comfortable with ambiguity, generating multiple ideas (or correct answers), and being trans-disciplinary.

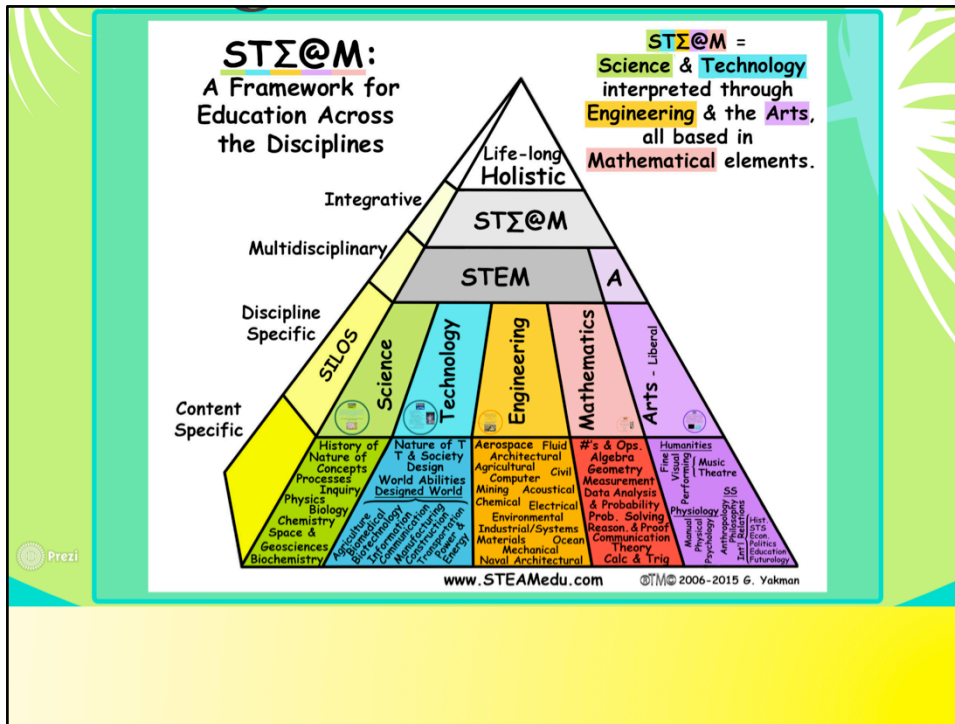
Participation in arts programs boosts student attention, cognition, working memory and reading fluency (Pomeroy, 2012).



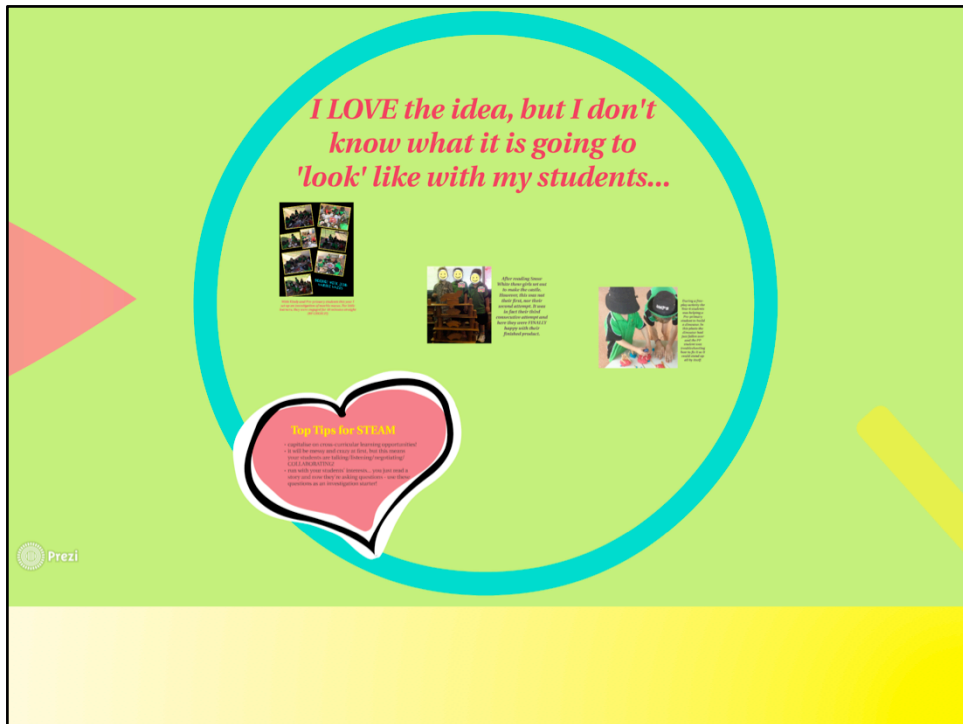
The A is valid. Read her paper here as to why she personally believes:

Many believe 'Ugh, art. Don't need it' and honestly I at first thought *why integrate art? Is it really necessary?* Yes you are right we already do have artists, lots of them, but it's not about becoming an artist. Including the liberal arts means developing a student's capacity to think creatively and make connections, to teach for creativity which does mean being comfortable with ambiguity, generating multiple ideas, and being trans-disciplinary. Cindy Foley has a fantastic TED talk on this matter – I recommend it.





When effectively implemented, STEAM is an effective, integrative approach reflective of the current curriculum requirements and is an opportunity to work through authentic, meaningful and engaging projects with your students.




I can hear you now “BUT HOW DO I DO IT?”

I believe there is no formula, but when I think of the work I have done with Kindy and Pre-primary students...



This was an activity for science week where students could choose to create a marble maze. Would you believe that my Kindy students chose to participate in this task for a solid 40 minutes? Then requested they keep doing it in the classroom?

Initially I gave students only one marble, but as they collaborated they asked for more marbles – the red one can do the green arches and the blue one can only do the purple arches, troubleshooted how else they could have the marble move (blow it instead which led students to ask for a straw but by the time I got one they had made their own straw-type device), and set challenges such as tall, narrow arches and low wide arches.



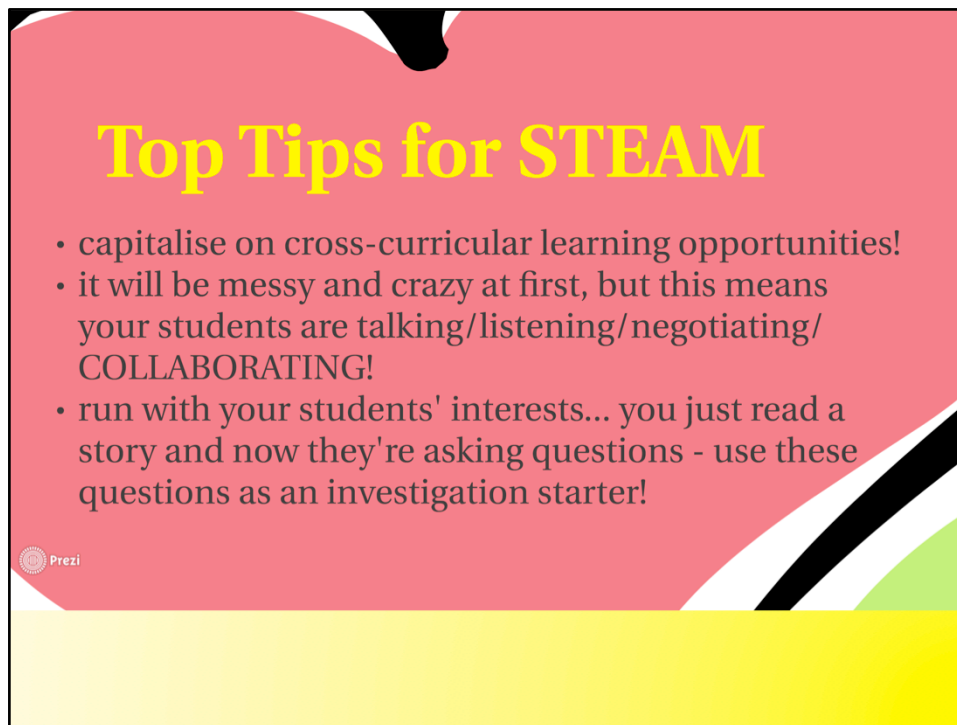
*After reading Snow White these girls set out to make the castle. However, this was not their first, nor their second attempt. It was in fact their third consecutive attempt and here they were **FINALLY** happy with their finished product.*

Prezi

After a whole class shared reading of Snow White these Pre-primary students were set the task of creating a setting from the story. Collaboratively they built this castle. Did you realise though that this was in fact their third re-design? The first time it wasn't grand enough, the second didn't look 'pretty' and this time they liked it because of the symmetry.



During a free-play activity the Year 6 students was helping a Pre-primary student to build a dinosaur. In this photo the dinosaur had just fallen over and the PP student was troubleshooting how to fix it so it could stand up all by itself.



Jump in and try it!

Look for cross-curricular opportunities, the ones you may avoid because they're too noisy or too messy. It will be at first, but this also means your students are talking, listening, negotiating and collaborating.

Start with your students' interests – ask them! If they're engaged they will be learning.

Resist telling students 'the right answer'. That is the beauty – there is no right answer and there are multiple paths to get to one of the 'right' answers!

**Reference List**

Alltime10s. (2015, March 9). *10 things you didn't know about Albert Einstein*. [Video file]. Retrieved from <https://www.youtube.com/watch?v=UmOaQdVUAI>

Australia. Department of Education and Training. (2015). Restoring the focus on STEM schools initiative. *Department of Education and Training*. Retrieved from <https://www.studentsfirst.gov.au/restoring-focus-stem-schools-initiative>.

Australian Children's Television Foundation and Education Services Australia. (2011). *My Place*. Retrieved from <http://www.myplace.edu.au/copyright.html>

Australian Curriculum, Assessment and Reporting Authority. (2016). *Australian Curriculum*. Retrieved from <http://www.australiancurriculum.edu.au/>.

Education Council. (2015). *National STEM School Education Strategy*. Retrieved from [www.educationcouncil.edu.au](http://www.educationcouncil.edu.au).

BigIdeasFest. (2012, February 9). *Georgette Yakman: STEAM – Learning that is representative of the whole world*. [Video file]. Retrieved from <https://www.youtube.com/watch?v=QtjuALN4qrw>.

bio. (2016, January 5). *Albert Einstein: Mini Biography*. [Video file]. Retrieved from <https://www.youtube.com/watch?v=KyjQJBD5V4>

Martin, L. (January 24, 2014) 10 reasons why arts in education is so important for kids. [www.learningliftoff.com](http://www.learningliftoff.com)

Normington, K. (2016, July 7). Creating a head of STEAM. Retrieved from <http://www.staff.royalholloway.ac.uk/news/2016/02/26/professor-katie-normingtons-article-creating-head-steam/>

nowUknow. (2014, December 16). *Top 7 Leonardo da Vinci Inventions*. [Video file]. Retrieved from <https://www.youtube.com/watch?v=PwOllGGDVJE>

Pomeroy, S. (2012, August 22). From STEM to STEAM: Science and art go hand in hand. <https://blogs.scientificamerican.com/guest-blog/from-stem-to-steam-science-and-the-arts-go-hand-in-hand/>

## References (page 1 of 2)

(To save your eyes squinting, this powerpoint does have a modified format for references – I'd like you actually be able to read the reference list in case you'd like to further investigate!)

**Reference List**

RameshRamanujan. (2011, October 6). *Stay hungry...Stay foolish. Amazing Steve Jobs speech at Stanford with English subtitles*. [Video file]. Retrieved from <https://www.youtube.com/watch?v=gO6cFMRqXqU>

Rachymac. (2009, April 11). *Remember the 1990s...* [Video file]. Retrieved from: [https://www.youtube.com/watch?v=A\\_JpP0z79VQ](https://www.youtube.com/watch?v=A_JpP0z79VQ)

Regularstyle. (2010, January 5). *2000-2010 in review*. [Video file]. Retrieved from: <https://www.youtube.com/watch?v=wlsO-17n4vk>

ReneBrokop. (2013, April 21). *Best marketing strategy ever! Steve Jobs think different/Crazy ones speech (with real subtitles)*. [Video file]. Retrieved from: <https://www.youtube.com/watch?v=keCwRdbwNQY>

Root-Bernstein, R. (2015). Arts and crafts as adjuncts to STEM education to foster creativity in gifted and talented students. *Asia Pacific Education Review*, 16, 203-212.

Taylor, P. C. (2016, August 9).: Why is a STEAM curriculum perspective crucial to the 21st century? Retrieved from [http://research.acer.edu.au/research\\_conference/RC2016/9august/6](http://research.acer.edu.au/research_conference/RC2016/9august/6)

TEDxTalks. (2014, November 26). *Teaching art or teaching to think like an artist?* [Video file]. Retrieved from <https://www.youtube.com/watch?v=ZcFRfb2ONk>.

Vat19. (2007, March 16). *Mona Lisa – Why so Famous?* [Video file]. Retrieved from <https://www.youtube.com/watch?v=litbjszd1kM>

Yakman, G. (2016, June 6) STEM to STEAM: Critical Article and STEAM Founder’s G. Yakman’s Response. STEAM Education. Retrieved from <http://steamedu.com/stem-to-steam-critical-article-and-steam-founders-g-yakmans-response/>

Yakman, G. (2016). STEAM Education. Retrieved from [www.steamedu.com](http://www.steamedu.com).

## References (page 2 of 2)

(To save your eyes squinting, this powerpoint does have a modified format for references – I’d like you actually be able to read the reference list in case you’d like to further investigate!)





I hope you are inspired, and I hope you see that STEAM is, as Yakman describes, learning that is representative of the whole world.