



Planning for Effective STEM Learning Experiences

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‘Social behaviour must be conceived
of as actions, mediated by
meanings, not responses caused by
stimuli’

(Harré & Secord, 1972, p29)

- **2007** our students ranked about 10th internationally.
- **2011** - deteriorated and were significantly outperformed by 18 countries in **Science** and 17 countries in **Mathematics**.
- Being **no longer in the top 10** is bad enough, but being on a downward trajectory is even worse.

Foundation for Young Australians report analysed 4.2 million job ads (2012-2015) finding-

- Demand for digital skills **up 212%**
- Critical thinking skills demand **up 150%**
- Call to teach Enterprise skills in primary school.
- **35% of 15yos** did not meet Australian baseline proficiency for **Problem Solving**. (rank 11th internationally)



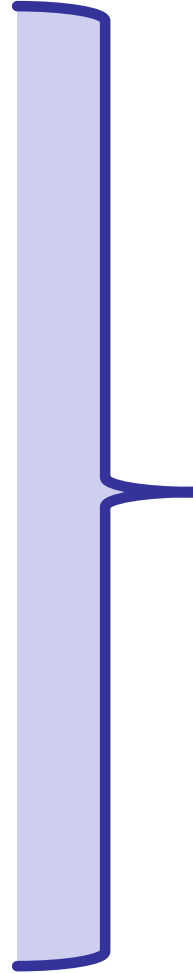
1. Creative thinking,
2. Collaborative skills,
3. Communication,
4. Critical thinking,

1. Problem solving,
2. Communication skills,
3. Digital literacy,
4. Team work,
5. Critical thinking,
6. Creativity,
7. Presentation skills
8. Financial literacy.



Skills & Attitudes

- Problem – solving
- Persevering
- Designing
- Investigating
- Inquiring
- Creating
- Collaborating
- Communicating
- Critical Reasoning



**21st
Century
Skills
&
Attitudes**

Key focus - **I**dentifying, **T**racking and **A**ssessing learning in **STEM** experiences.

- Review STEM in action in the past and implications.
- Theoretical frame for implementing and assessing learning.
- Implementation of pedagogical approaches to make learning visible.



Coding, robotics, drones, mobile and on-line learning, virtual and remote labs, 3D printing, games and gamification, VR and AR immersive learning environments, wearable tech, Maker Spaces, Digital designs, Internet of Things, & tools.

- **Engineering** – solving problems in effective and efficient ways.
- **Mathematics** – a way of logically organising numerical relations.

- On **two STEM** men – role models for today's learners.
- Leonardo and Michelangelo.
- What can we **learn** from history...?
- L & M had very **similar experiences** ... in their childhoods, in early affirmation, the areas they studied and in their social opportunities.

- **Renaissance STEM man (1452 – 1519)**
- **Studied engineering** and botany
- Brilliant sculptor, painter, architect, musician and inventor.
- Mastered mathematics and science.
- Had very few friends
- He drew the natural world of fossils, rocks and caves.

- Informal education included Latin, geometry and mathematics.
- He was a **logical thinker** and used **empirical methods**.
- His childhood was spent with his uncle and grandfather, tending animals, exploring the land; enjoying sketching these.

- **Renaissance STEM man**
- **Studied engineering** and anatomy
- Brilliant sculptor, painter, architect and poet.
- Mastered mathematics and science.
- ****As a 6yo lived with a nanny and a master stone cutter.**

Making David-Process!

- Worked in secrecy ~ outside; when it rained he was soaked ~ this may have-
- Inspired his method of work; he created a wax model, and submerged it in water.
- He let water levels drop; sculpting what he could see.
- He slept sporadically; in his clothes and boots; rarely eating.

- Both were loners, both had learnt to draw, and annotated their drawings.
- This has made their thinking visible to us.
- Both had childhood experiences that can be seen to influence their skill sets.

- **Schatzki's** social practice theory;
- **Di Sessa's** phenomenological primitives;
- **Bourdieu's** theory of habitus and
- **Giddens's** concept of practice empowering agency ... establishing the practice
- Forming our doxa (Bourdieu) ~ unconscious reality that shapes our moment-by-moment actions through values and beliefs.
- Primary schools have a responsibility to provide breadth and depth of experiences.

'Doing and Saying'

- Leonardo and Michelangelo were acclaimed as talented when young.
- Then - socialised and immersed into the nature, language and practices of artistic cultures.
- Watching, copying, modeling people in the world around them.
- Impacted on them ~ influencing their hexis.



Drawing ...

- Drawing ~ as a form of communication, of problem solving, and of collaborating.
- Creates and supports problem solving and resolving skills.
- ** Makes **thinking** visible
- Over time makes **learning** visible
- To – **both** the learner and the teacher



- Michelangelo and Leonardo were both reclusive - and preferred to work alone - now deemed to be HFA.
- However - we know their thinking; their challenges, their reasoning processes – from over 500 years ago.
- Because ... they drew and wrote their ideas – these are evident to us, still, on paper now!



What is visible!

- Making the known visible
- Making the learning visible

Also made visible ...

- thinking – visible
- problems – visible
- decisions – visible
- choices – visible
- known – visible
- the Unknown – visible -

- More than drawing and labeling ...
- Showing thinking – reasoning and decisions – making explicit the known; decisions made, what is accounted for and not accounted for...
- Annotated drawings can become the object at the centre of the conversation (Harré, 1999; Redman & Fawns, 2010)



- Annotated Drawings can make visible; thinking processes, ideas, understandings, challenges and problems.
- Enables tracking of decisions, reasoning, trial and error, the use of data to inform decisions and choices.
- Provides evidence of impact on learning...



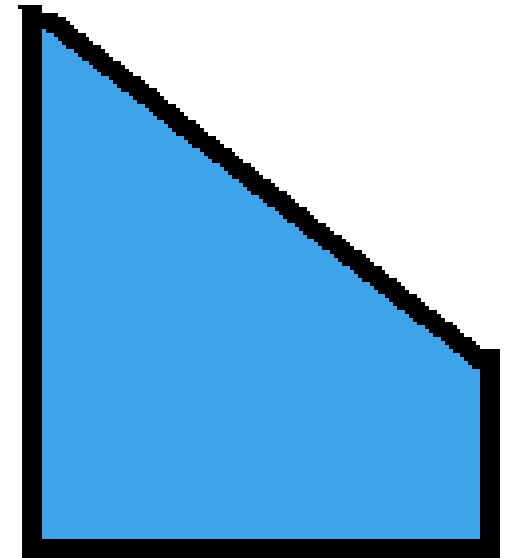
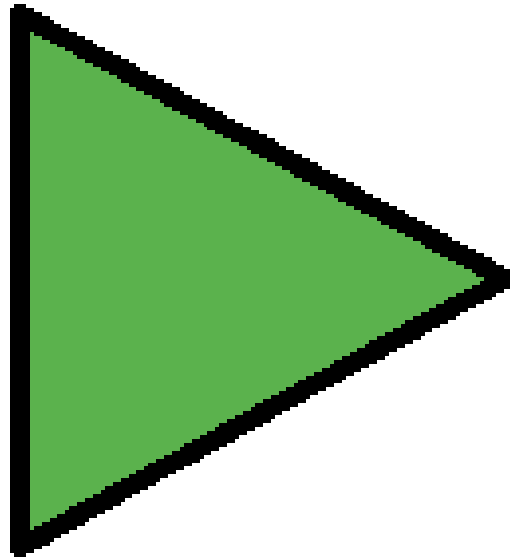
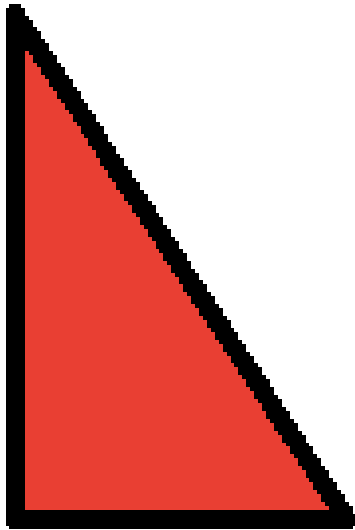
- 1) Investigate** - and ID the problem /history /challenges
- 2) Design** - solutions in response to the above ~ draw, annotate, justify decisions,
- 3) Produce** - prototype, model solution,
- 4) Evaluate** - calibrate, modify, and assess... and investigate, re-design...



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Possible Fin Designs

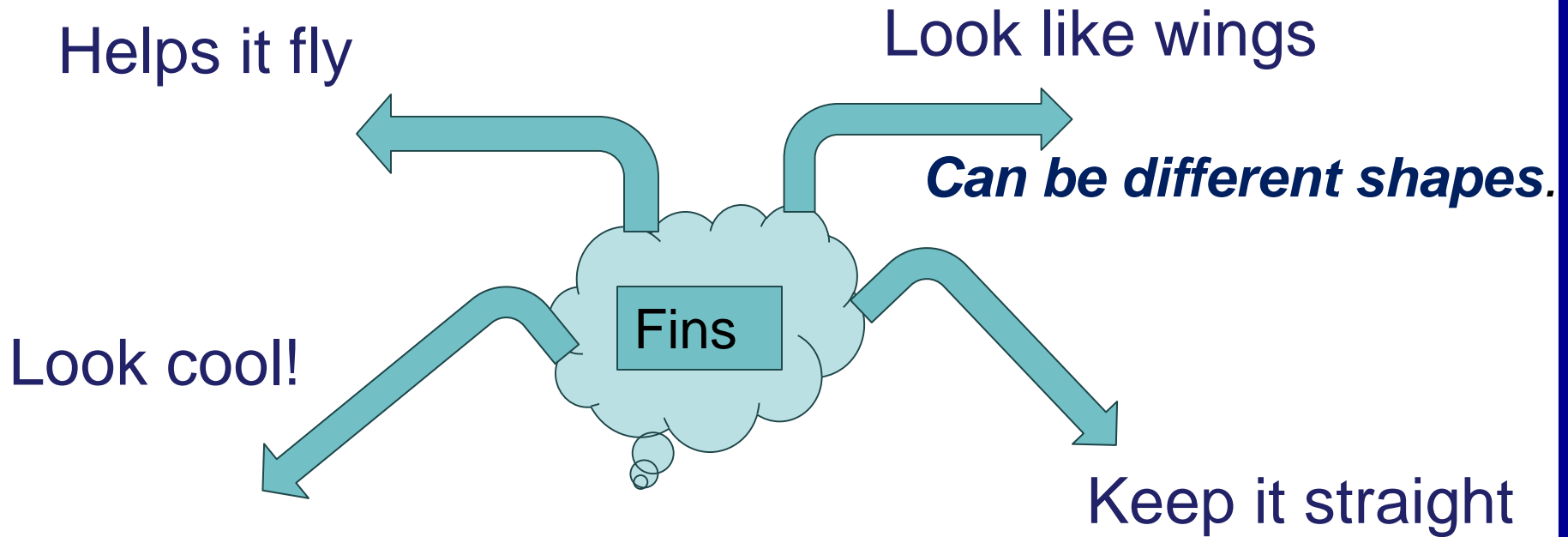


- Personal Meaning Making maps make explicit initial thinking.
- Completed **individually**, they become personal feedback.
- They can be a **social** conversational piece when shared with others.
- They document thinking ... and learning.

(Redman et al, 2014; Redman & James, 2016)



Re~iterative PMM Maps



Hard to stick on! Sticky tape did not work... Low temp hot glue did 😊

If the fins are crooked they fall off and the rocket wobbles.

Desire ...

- Learners with responsibility
- Teachers with accountability
- Working together
- Visible 'and shared' Learning
- And Teaching with a purpose
- Tracking Impact!