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Embedding critical and creative thinking into science and mathematics initial teacher education programs and the flow on effect to schools

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The IPOML Project:

The 2012 report of the Australian Chief Scientist (Chubb et al., 2012) argues that Australia, like the USA and other industrialised nations, has stagnated in producing the M&S teachers and students on which our economy depends for sustainability and development.

The *Project* addresses two critical issues in mathematics and science (M&S) education in Australian schools:

1. the lack of confidence of teachers of mathematics and science, particularly in primary school, and

2. the lack of student interest in mathematics and science, particularly in middle years of high school.

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Current curriculum have a genuine focus on trying to bring real world mathematics/science into the classroom, to enhance classroom studies, **but the ideal mathematics/science classroom should be about the real world of mathematics/science**. We are trying to show pre-service teachers and school students **that mathematics and science is 'out there' in the real world** and that our classrooms should reflect this.

Overall Project Goals	Project strategies for Pre-service teachers
1. Collaboration between faculties, schools or departments or mathematics, science and education	1. Regional approaches to mathematics/science content 2. Student centered rather than didactic learning approaches, e.g., problem solving or scenario-based pedagogies 3. Mathematics/scientific thinking in everyday life "thinking like a mathematician/scientist" 4. Understanding their emotions and those of students in their classrooms 5. Transferrable teaching skills, relatively independent of subject-specific content knowledge
2. Curriculum arrangements for mathematics and science pre-service teachers	
3. Developing commitment to, and new capabilities for, working in regional, remote and indigenous communities	

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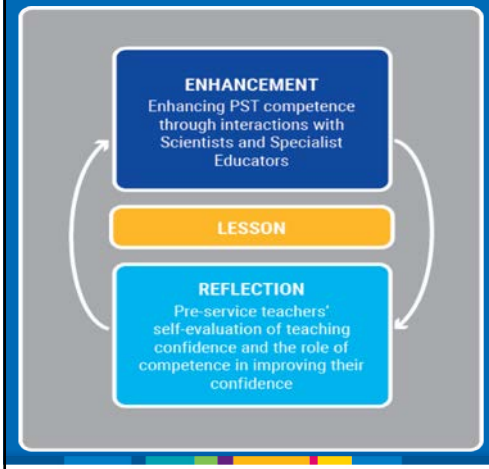
The Enhancement-Lesson-Reflection (ELR) process.



Enhancement: Interactions with mathematics and science researchers and education specialists – in recent times through video recordings. The Enhancement involves collaborative team discussions in order to produce a plan for a 'Teaching Lesson' based on familiar real-world interactions, generally in a student-centred problem-solving context.

Reflection: The Teaching Lesson is followed by self-reflection or collaborative reflection around affect-based critical moments in teaching – how you felt while you were teaching and why you felt that way.

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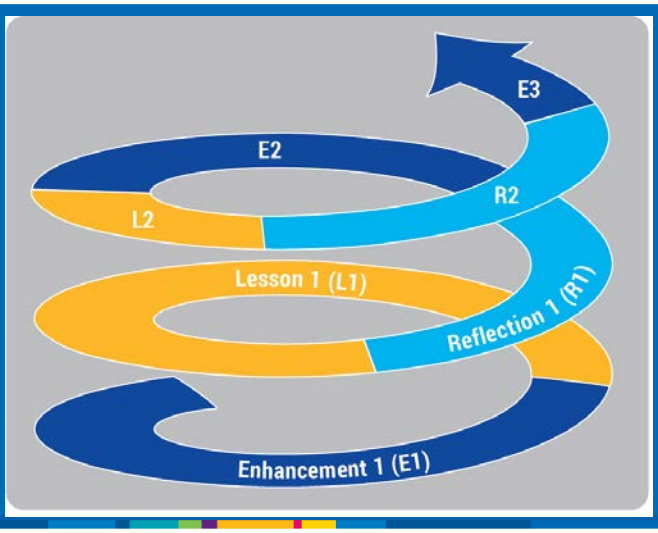

The iterated ELR process:

At the end of each ELR sequence, data collected during the process is analysed in order to determine how to re-configure the discussions/lessons in the following iteration. This allows the process to be more effective in ensuring delivery of lessons related to the project goals and strategies.

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Case 1: Canadian Lead PS

Canadian Lead Primary School

E Enhancement module	Develop a lesson on a curriculum topic with guidance from a science or mathematics expert and a pedagogy expert to draw out the key concepts with everyday examples.
L Lesson module	Conduct the lesson while making a video recording.
R Reflection module	Use group and self-reflection on positive and negative emotional highlights (critical moments) and on planning the next lesson.

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The original task…..

MTeach(Prim) Program
EDFGC5705 – Understanding and Investigation Our Worlds

Assessment Task 1:
Curriculum Research Project

- A written essay researching science education pedagogies and resources, and how they might effectively be used
- No practical component
- Due in week 5

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The new task with the ELR process…..

MTeach(Prim) Program
EDFGC5705 – Understanding and Investigation Our Worlds

Assessment Task 1: Curriculum Research Project (2016 / 2017 / 2018)

Week 1 – Introduction, form groups and start researching and reviewing resources, pedagogies, finding ideas for lessons

Week 2 (E) – Enhancement – expertise and pedagogy support finalising group's lesson plans and resources

Week 3 (L) – Teach Lessons – in groups, with Primary School students. Video lessons

Week4 (R) – Review videos – identify critical moments, share reflections

Write a reflective essay, critically evaluating the above process

- Due in week 5

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THEORY INTO PRACTICE (2016 / 2017 / 2018)

- Focus on P-1-2's in response to earlier Course eVALUate feedback that we needed to do more with the Early Years
- Built on a partnership already established with a local Primary School
- The task is conducted in early Term 3, so we had to fit in with the PS's science curriculum in early Term 3
- This is 'Physical Sciences' for F-2 – "The way an object moves depends on a variety of factors including their size and shape: a push or a pull affects how an object moves or changes shape"
- PSTs formed 4-5 groups of 4-5 PSTs, and collaboratively designed a lesson with support from the 'Enhancement' process.
- This produced 4-5 lessons that could be run with the PS's 4-5 x F-2 classes
- PSTs took turns to lead the lesson while being videoed
- In the following week PSTs identified Critical Moments and did shared reflections

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THEORY INTO PRACTICE (2016 / 2017 / 2018)

Examples of lesson themes:

- '10 Pin Bowling' with PET bottles and soft balls
- Model car races down a ramp
- Balloon rockets
- Parachutes
- Making sounds and musical instruments
- Lollie catapults and marshmallow shooters

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Demonstrated facets of creative thinking

The ELR process has enabled creative thinking within planning of science.

Fluency – the ability to produce a plethora of ideas

Flexibility – the ability to produce different classes of ideas

Originality – the ability to produce novel ideas

Elaboration – the ability to produce, extend, transform existing ideas.

Dr. Roy Skinner – Investigating Scientifically (W.A.)

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Demonstrated facets of creative thinking

The ELR process has enabled creative thinking within the science classroom.

There are four major dispositions that creative people have:

- **Imagination**
- **Curiosity**
- **Enjoyment** of **Complex tasks**
- **Risk-taking** behaviour (breaking boundaries)

Dr. Roy Skinner – Investigating Scientifically (W.A.)

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Case 2: Miners Rest PS

Miners Rest Primary School incorporating Miners Rest Kindergarten
"With knowledge, We grow"

Year 3 Lesson topics:

- Lesson 1: Time – Making a clock (Maths)

  Relating significant times of the students days to the positions of the hands on the clock.

- Lesson 2: Representing Fractions (Maths)

  Using the student lockers and other common items in the classroom to make sense of fractions.

Year 6 Lesson topics:

- Lesson 1: Painting a House (Maths)

  Students use their own model houses to prepare a quote for painting.

- Lesson 2: Fake Gold (Science and Maths)

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Lesson 2: Fake Gold (Science and Maths)

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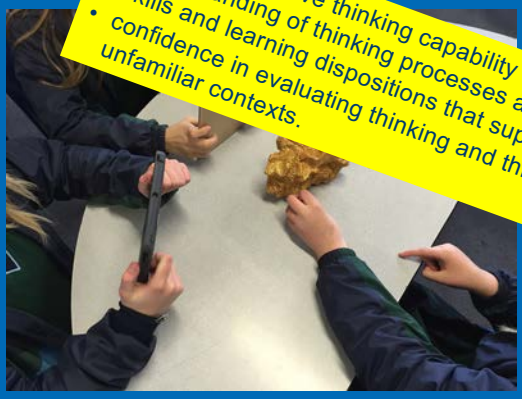
Lesson 2 ... ld (Science and Maths)

Critical and creative thinking capability aims to ensure that students develop:
- understanding of thinking processes and an ability to manage and apply these intentionally
- skills and learning dispositions that support logical, strategic, flexible and adventurous thinking
- confidence in evaluating thinking and thinking processes across a range of familiar and unfamiliar contexts.



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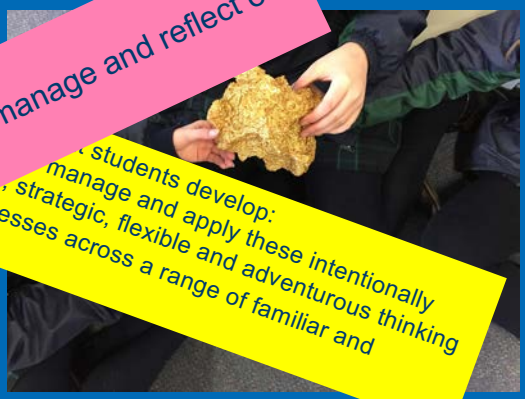

Strand : Meta-Cognition
Explore the use of strategies to understand, manage and reflect on thinking and learning processes

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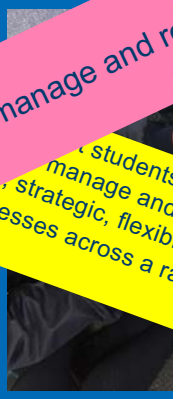

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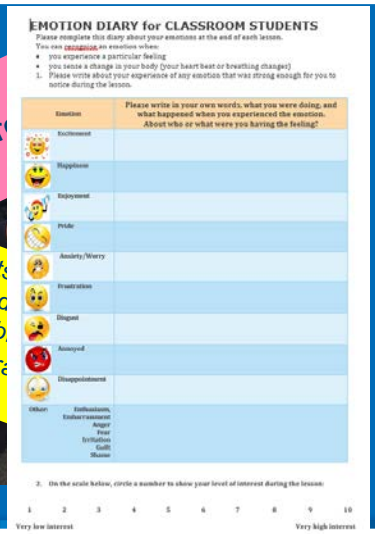
EMOTION DIARY for CLASSROOM STUDENTS

Please complete this diary about your emotions at the end of each lesson.
You can recognise an emotion when:
- you experience a particular feeling
- you sense a change in your body (your heart beat or breathing changes)

1. Please write about your experience of any emotion that was strong enough for you to notice during the lesson.

Emotion	Please write in your own words, what you were doing, and what happened when you experienced the emotion. About who or what were you having the feeling?
Excitement	
Happiness	
Enjoyment	
Pride	
Anxiety/Worry	
Frustration	
Disgust	
Annoyed	
Disappointment	
Other: Enthusiasm, Embarrassment, Anger, Fear, Irritation, Guilt, Shame	

2. On the scale below, circle a number to show your level of interest during the lesson:

1 2 3 4 5 6 7 8 9 10

Very low interest — Very high interest

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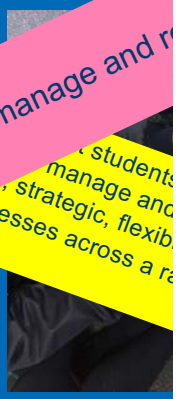

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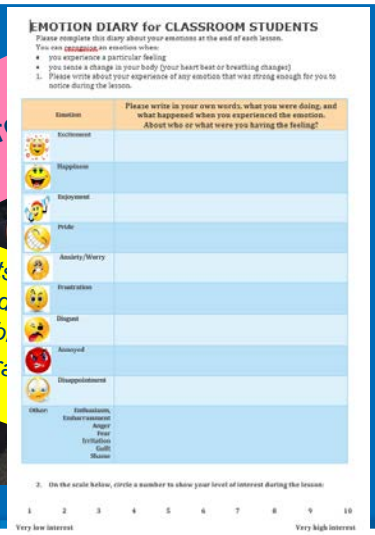

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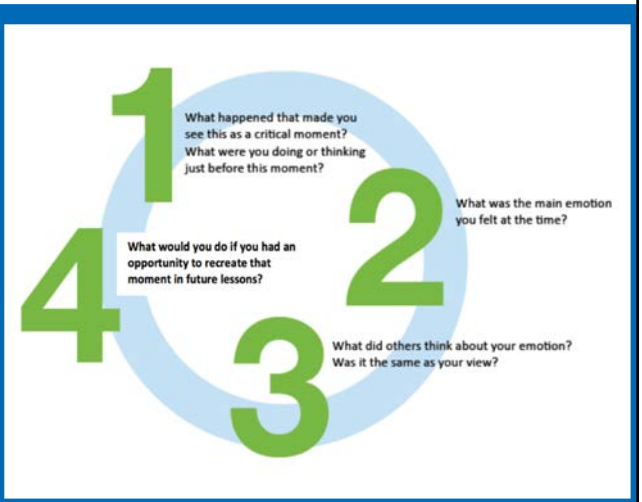
REFLECTION MODULE - (Metacognition)

The reflection process is structured to develop a pre-service teacher's awareness of their emotions and, with guidance and support from observers, to increase positive experiences that create confidence and change negative behaviours and frames of mind. The reflection discussion is structured around the following questions



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PONDER for a moment:

How could aspects of this process be beneficial for the development of Critical and Creative Thinking in your own school and university learning settings?

THOUGHTS?

QUESTIONS?

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