

RELATIONAL

(This is the transcript for the video found at <https://youtu.be/DCzCL01jY9I> and at <https://vimeo.com/397728149>)

Greetings fellow mathematicians!

Mathematician and teacher Richard Skemp found that there were two ways to teach and learn maths and asked the question, 'Does it matter?'

One way of teaching and learning maths Skemp called Instrumental.










Instrumental means that we have a rule or a procedure and we have the ability to follow it. Examples of rules and procedures include: finding the area by multiplying length by width; and algorithms for addition and subtraction and multiplication and division. Other examples of instrumental explanations can be easily found on other web sites.

Unfortunately the Instrumental approach to teaching and learning maths is widespread.

The learning theory was that children practice the rules or procedure, and understanding will follow. Current learning research tells us, that in many cases, understanding never followed; incorrect understanding followed; or if correct understanding did follow the child did not know whether it was important understanding or related to any other parts of maths.

Relational understanding means the child knows both what to do and they can explain why. The child develops deep understanding of concepts, and the relationships between concepts. Examples of Relational understanding include explaining that area is the amount of space a shape takes up in two of the three dimensions, relating this to the three dimensions being up and down left to right and front to back; thinking additively about place value to add and subtract; and thinking multiplicatively about place value and the distributive property to multiply and divide, relating division to fractions. Maths abounds with related concepts.

Skemp identified the short and long term effects of teaching and learning instrumentally and relationally.

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RELATIONAL v INSTRUMENTAL MATHEMATICS		
	CHILD is learning INSTRUMENTALLY	CHILD is learning RELATIONALLY
TEACHER is teaching INSTRUMENTALLY	 Short term effect: All appears well because there is a match between teacher and child goals. Teacher and child 'do' mathematics. One sign the child is learning instrumentally is that they don't know if they are right until the teacher tells them.	 Short term effect: The child tries to understand relationally what is being taught instrumentally. The child tries to develop deep understanding but is being taught shallowly.
TEACHER is teaching RELATIONALLY	 Long term effect: The child learns ever more rules, developing shallow understanding, causing problems when a question does not fit a 'rule'. The child may continue to study mathematics to pass tests, but will drop mathematics as soon as they can.	 Long term effect: The child feels that they are not smart enough to Understand mathematics. They disengage. They drop Mathematics as soon as they can. As adults, they tell their children that they couldn't do mathematics either.
	 Short term effect: Frustration for the teacher because the child doesn't want to know why. Frustration for the child because they just want to know how to do it.	 Short term effect: The child and the teacher both develop deep relational understanding.
	 Long term effect: The child and the teacher develop relational understanding of mathematics. Child continues to study mathematics and works in a mathematics related career.	 Long term effect: The child and the teacher both continue to develop deep relational understanding of mathematics. Child continues to study mathematics and works in a mathematics related field and saves the world!

Imagine a teacher is teaching instrumentally, telling children a series of rules and procedures, and imagine **the child wants to learn instrumentally** because the child has been taught that maths is about getting the right answer. The short term effects is that all is well. There is a match between the goal of the teacher and the child. The child and the teacher both 'do' maths. One sign that the child has instrumental understanding is that the child does not know whether their answer is correct until the teacher or an adult tell them. The long-term effect is that the child has to learn evermore rules, developing shallow understanding of mathematical concepts, causing problems when a question does not fit a rule - problem solving becomes a real problem. Children may continue to study maths, passing tests using their instrumental understanding by following rules and procedures, but they will drop maths as soon as they can. Instrumental understanding does not provide the basis for a maths-related career.

Imagine a teacher is teaching relationally, using questioning and investigations to allow the child to develop deep understanding of concepts, and relationships between concepts, and their capacity to explain their understanding, and imagine that **the child wants to learn instrumentally** because the child has previously been taught that maths is about getting the right answer. The short term effect is frustration for the teacher - the child doesn't want to know why; and frustration for the child - the child just wants to be told how to do it. The long term effect, as the teacher continues to teach relationally, is that the child and the teacher both develop relational understanding of maths, the child continues to study Maths and has the understanding to work in a maths related career.

Now let's imagine the saddest case of all. The teacher is teaching instrumentally but the child wants to learn relationally. The short-term effect is that the child tries to understand relationally but is being taught instrumentally. The child is trying to develop deep understanding of concepts and relationships between concepts, but they are being taught in a shallow way. The long term effect is that the child feels that they are not smart enough to understand mathematics, they disengage, they dropped maths as soon as they can. As adults they tell their children that they couldn't do maths either.

And now let's imagine the happiest case of all. The child wants to learn relationally, and the teacher is teaching relationally. The short-term effect is that both the child and the teacher continue to develop deep understanding of both what to do and they can explain why. The long term effect is that the child and teacher develop Relational understanding of mathematical concepts, the child continues to study maths, builds a career in a maths-related field, and saves the world!

George Land's research into Divergent and Creative Thinking revealed some startling results.

The creative and divergent thinking of 3 to 5 year olds was assessed using the same assessment that NASA uses to select engineers and scientists. At 3 to 5 years old, 98% of the children scored at genius level in divergent and creative thinking. The same children were assessed 5 years later - at 8 to 10 years old, only 30% still scored at genius level. The same children were assessed 5 years later - at 13 to 15 years old, only 12% scored the genius level. When they assessed adults over 25, only 2% scored at the genius level in divergent and creative thinking.

Land concluded that **non-creative behaviour is learnt and that creative behaviour is unlearned** through instrumental teaching and learning, while Relational teaching and learning allows and encourages children to think creatively and divergently. Research consistently finds that reasoning is missing from classroom.

The Australian National Numeracy Review found that students need to learn mathematics where they will have to use mathematical reasoning processes,
choose mathematics that make sense in the circumstances
make assumptions - resolve ambiguity and
judge what is reasonable.

They found that **in Australia there is very little evidence of lessons involving mathematical reasoning**, and that there exists a syndrome of shallow teaching where students are asked to follow procedures without reasons. They found that students strategies and reasoning could well challenge the teacher's mathematical comfort zone. While instrumental teaching and learning involves following rules and procedures without reason.

Relational teaching and learning allows and encourages children to apply reasoning to their learning. Relational teaching and learning develops both the students and the teacher's deep understanding of mathematical concepts, and both the students and the teacher's meta language and capacity to explain.

Research into 21st century learning tells us that when a child asks a mathematical question, it is no longer the teacher's role to answer it. The teacher is not the keeper of all knowledge. With the amount of knowledge in the world doubling every 18 months, it would be impossible for the teacher to be the keeper of all knowledge! Children have all the knowledge in the world available to them.

Children need to know

- some knowledge but also
- how to locate more knowledge
- how to assess and adapt to new knowledge
- how to communicate knowledge and
- how to use knowledge to create more knowledge.

When a child asks a mathematical question, they are ready to investigate to find the answer. They use the knowledge that they already have to investigate to make more knowledge, to assess the new knowledge, to communicate their knowledge, and to create more knowledge. When a child asks a mathematical question, they will not just be asking the teacher - they will be asking other the students. There are 30 brains in the classroom - we can use all of them to learn/

When a child asks a mathematical question, **Vygotsky's research into the 'Zone of Proximal Development'** tells us the teacher cannot answer it. Our level of understanding may be so far from the child's level of understanding, that the child cannot learn from us. The child needs to be learning with others within their 'Zone of Proximal Development' - other children.

This means that as teachers, we may not now teach the way that we were taught. We may have been taught 20th century learning, where knowledge was delivered in a sequential, logical, controlled way. But we may not fear being taken out of our comfort zone - because children will be in their comfort zone. And as they question and investigate with others within their 'Zone of Proximal Development', we teachers will find that our own knowledge and understanding increases.

21st century learning is Relational. What exactly does Relational teaching and learning looks like? It looks like questioning, investigating, and explaining. All teaching resources - every Teaching Plan, Video, Investigation, Reflection and Problem at 'A Learning Place A Teaching Place' involve questioning, investigating, and explaining, to allowed children and teachers to develop Relational understanding of concepts.

The Concept Sequences provide information and guidance to related concepts to ensure that children are explicitly investigating and explaining the relationships between concepts. As we as teachers read the Teaching Plans, watch the Videos and plan the Investigations Reflections and Problems that our students will engage in, we teachers will find that our own knowledge and understanding increases.