Understanding "understanding"

(Carpenter, T and Lehrer R (1999) Teaching and learning mathematics with understanding)

To be mathematically literate in the 21st century being able to do mathematics is insuffcient - your students need to be able to understand the mathematics. They need to develop the ability and inclination to use mathematics effectively - at home, at work and in the community.

Virtually all complex ideas or processes can be understood at a number of levels and in quite different ways. Therefore understanding should be thought of as always developing rather than presuming someone understands or doesn't understand a given topic, concept or process.
Begin your report comments with " ....is developing an understanding of ...." and remember in your teaching you are assisting students to continue to develop an understanding.

How is understanding developed?

Understanding requires mental activity. All these forms of mental activity are highly interrelated.

Constructing relationship:
People construct meaning for a new idea or process by relating it to ideas or processess they already understand. Children begin to construct mathematical relationships before they come to school and in playbased environments. This early knowledge is the basis to further expand their understanding and forms the basis for formal mathematical concepts, operations and symbols required for the school mathematics curriculum. Learning with understanding involves developing relationships that reflect important mathematical principals. For example: multi digit addition and subtraction is related to basic concepts of place value.

Extending and applying mathematical knowledge:
Developing understanding involves more than simply connecting new knowledge to prior knowledge. It also involves the creation of rich integrated knowledge structures. When knowledge is highly structured, new knowledge can be related to, and incorporated into existing networks of knowledge. When students see a number of critical relationships among concepts and processes they are more likely to recognise how their existing knowledge might be related to new situations. When knowledge is highly structured, there are multiple pathways to retrieving it. Structured knowledge is less susceptible to forgetting. Isolated bits of information are more difficult to remember.

Reflecting about experiences:
Routine application of skills requires little reflection but reflection plays an important role in solving unfamiliar problems. Problem solving often involves consciously examining the relationship between one's existing knowledge and the problem situation. To be reflective in their learning students must consciously examine the knowledge they are acquiring and in particular the way in which it is related both to what they already know and whatever other knowledge they are acquiring. Initially students have limited ability to reflect on their thinking. A characteristic of students developing understanding is that they are better able to reflect on their thinking.

Articulating what one knows

The ability to communicate one's ideas is a benchmark of understanding. This involves communicating, verbally, in writing or through pictures, diagrams or models. Articulation requires reflection. It involves extracting the critical ideas of an activity so that the essence of the activity can be communicated. In the process, the activity becomes an object of thought. If students can only copy what the teacher has recorded then reflection has not occured. Likewise filling in boxes on a worksheet requires little reflection.

The curriculum document is very clear on the expectations of articulating what students know:

Level 1: Communicates - using words, numbers and pictures

Level 2: Communicates - using words, diagrams (pictures) and symbols

Level 3: Communicates - using words, diagrams, symbols, with an understanding of equality

Level 4: Forms and solves simple linear equations

> If you value students' understanding, and communicating is valued as critical to understanding then ensure your assessment also allows the students to communicate their thinking: verbally, in writing or through pictures, diagrams or models.

The process of recording is part of the thinking process and is critical to understanding.

Further Reading: Teaching Primary School Mathematics & Statistics: Evidence Based Practice Chapter 16 Using Written recording to help children learn mathematics (Ell, Smith, Stensness & Major) NZCER Press 2010

Making mathematical knowledge one's own

Understanding involves the construction of knowledge by individuals through their own activities. They need to develop a personal investment in building knowledge.

Students (and teachers) who view knowledge as something they simply assimilate through listening, watching and practising do not perceive knowledge as something that is evolving and provisional.

Learners must adapt what they hear to their own ends not simply accept the reasoning because it is clearly articulated by an authority figure.

Learning is not private to the individual either. A student's personal involvement in learning with understanding is tied to classroom practice in which communication and negotiation of meanings are important facets.

> **An overarching goal of mathematics teaching is for students to develop a predispostion to understand and that they strive to understand because understanding becomes important to them.**

Points to remember:

- Not all students learn in exactly the same way,
- Doing an activity correctly does not necessarily mean the student has understood,
- Understanding does not always look the same in all individuals
- For an idea to be understood it must be related to other ideas, but there are many ways that ideas might be related.
- There is no one single pathway (or scheme of work) that ensures all students make the necessary relationship connections.
- Assisting the making of relationships is the role of the teacher - therefore the teacher must have some knowledge of relationships between ideas and be prepared to continually seek further relationship.

I know things but do I always understand what I know?

The Financial Literacy link is now available under the Student Resources heading in the directory

NZ Currency - activities to learn the coins and notes used in New Zealand.

Level 1 - 2 Activity Cards and Worksheets

Individual membership: ($45)
Please make sure you **Become a member** and pay your subscription BEFORE you create an account or your account will not be activated.
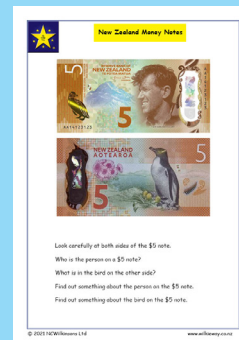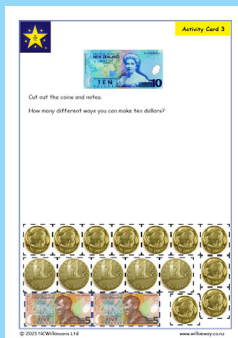
Reminder to school subscribers:
Please let new staff know you have a school subscription - if they create an account with a school email address their account will be activate.

July Featured Resource

Planning for Learning

- Overview Plan (Curriculum coverage)
Year 1
Year 2
Year 3 & 4
Year 5 & 6
Year 7 & 8
- Unit Plans - termly, integrated number & strand, concepts and key knowledge
- Curriculum support
- Student tracking

These plans provide you with a clear stucture and understanding of concepts, key knowledge and specific learning outcomes to be reflected in your daily planning.
Curriculum support material to assist development of teacher understanding to enable you to deliver learning for understanding.

The NZ Curriculum Document is the only mandated document for the teaching of Mathematics and Statistics in New Zealand.
The resources you use to teach and assess your students is a choice made by individual schools and teachers.

The learning progressions (https://curriculumprogresstools.education.govt.nz/) assist the teacher to understand the progress steps students make as they progress in their knowledge and understanding. The progress steps most often bridge the curriculum levels so there is no exact alignment.

I have created an approximate alignment using the progression exemplars and the curriculum elaborations (These can be found on the NZMaths website and fully explain what is meant by each of the achievement objectives given in the document)

It has been brought to my attention the PACT tool has revised its algorithms to match student achievement rather than accept that students are not actually reaching the desired levels as described in the curriculum.
In my opinion this is seriously dumbing down what our students can achieve with good teaching.
If we want to raise student acheivement we need to face the actual issues not continue to sweep them under the carpet. Back in 2002 the MOE recognised the teachers required much more support in the teaching of primary mathematics but refused to acknowledge it saying "It would open a can of worms"

Raising the requirement to NCEA level 2 for teacher entry will ensure teachers can do mathematics but not necessarily understand the mathematical concepts and relationships required for the teaching of primary mathematics with a focus on understanding. Most initial teacher training courses do not begin to address this so teachers are pretty much left to their own devices using what they know. I have seen first hand what professional learning for teachers can achieve - teachers need to be given the opportunity to be supported in their development of a deeper understanding of mathematical concepts and relationships. I will continue to develop resources to support individual teachers and whole school professional learning.

The Wilkie Way Teacher Challenge

The factory makes both bicycles and tricycles

Yesterday they used 12 wheels - how many bicycles and tricycles were made?

Tomorrow they have been told to use 24 wheels - what combinations of bicycles and tricycles could they make?