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Digital Maths: Challenges and Opportunities

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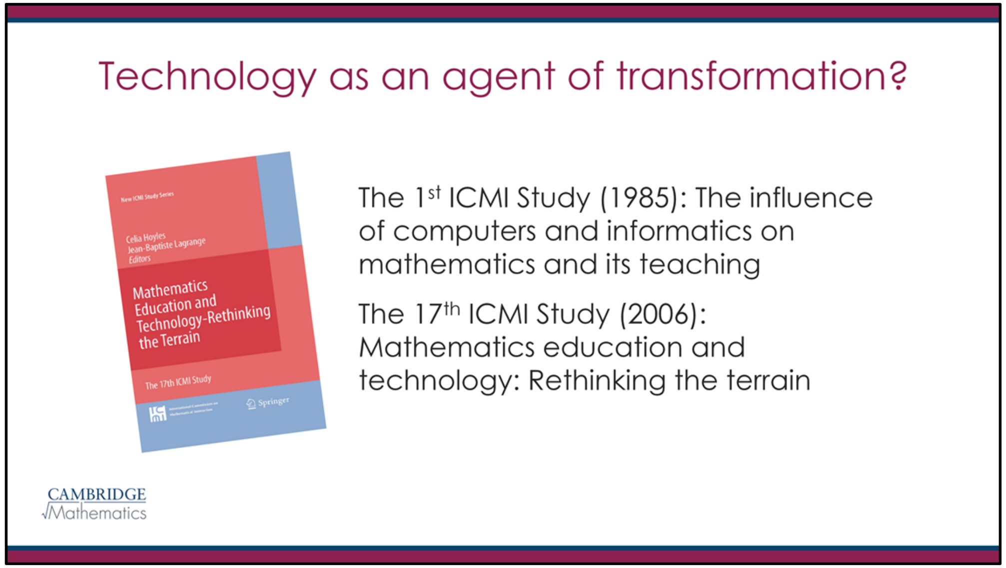
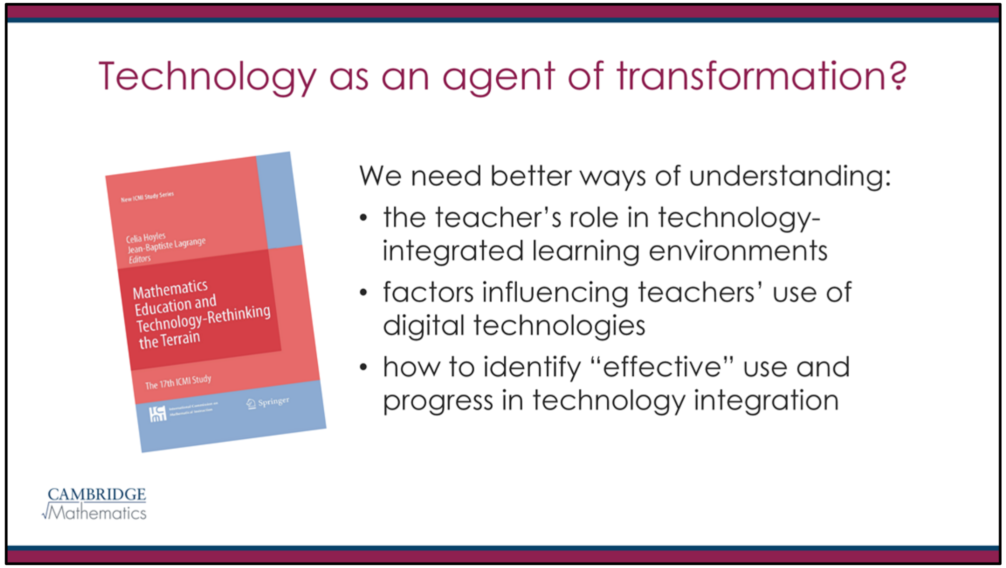


Begin with some historical context. ICMI - International Commission on Mathematical Instruction. ICMI commissions occasional Studies on topics of current interest in mathematics education. Studies are built around an international conference, leading to publication of a Study Volume to promote discussion and suggest future directions for research and development.

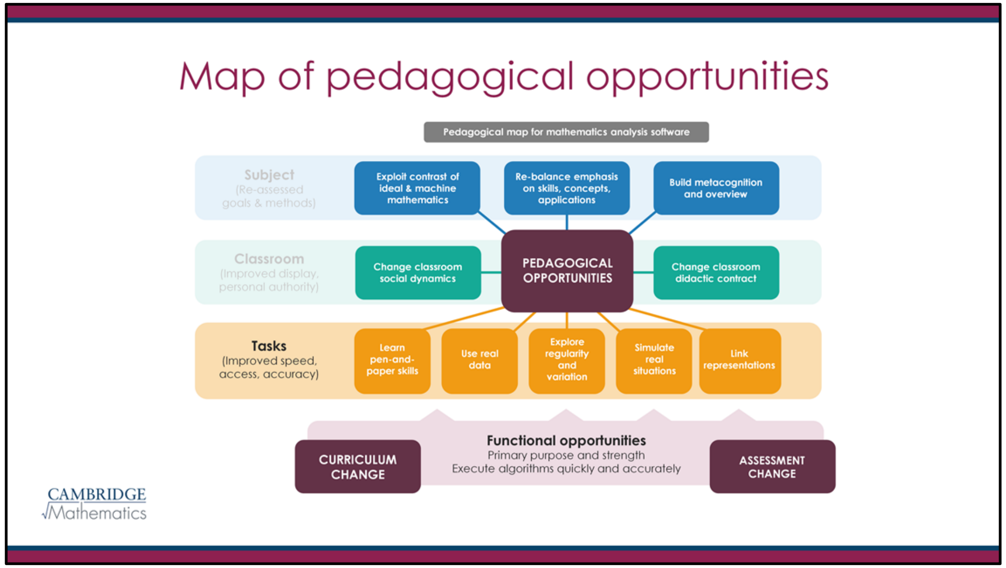
The very first ICMI Study was about digital technologies in mathematics education, and it presented an optimistic vision for future development. Twenty years later, the 17th ICMI Study revisited this same topic, with the realisation that change had proceeded more slowly than anticipated. In particular, we know now that large scale integration of digital technologies into mathematics education is a major challenge.

At the time of the first ICMI Study, research focused on the technology itself and its mathematical potential, as well as on students' cognititons. What was missing was inquiry into teachers' practices, institutional contexts, and curriculum change.



So if technology is going to provide opportunities to transform curriculum, pedagogy and assessment, what do we need to understand better?

For now I'm concentrating just on the last point.



Robyn Pierce and Kaye Stacey have proposed a taxonomy of the pedagogical opportunities that are afforded by mathematics analysis software as a way of drawing attention to possibilities for lesson design, of mapping current practice, or tracking professional growth. But the map can possibly be used for a broader range of digital technologies.

Opportunities arise at three levels that represent the teacher’s thinking about:

* the tasks they will set their students (using technology to improve speed, accuracy, access to a variety of mathematical representations);

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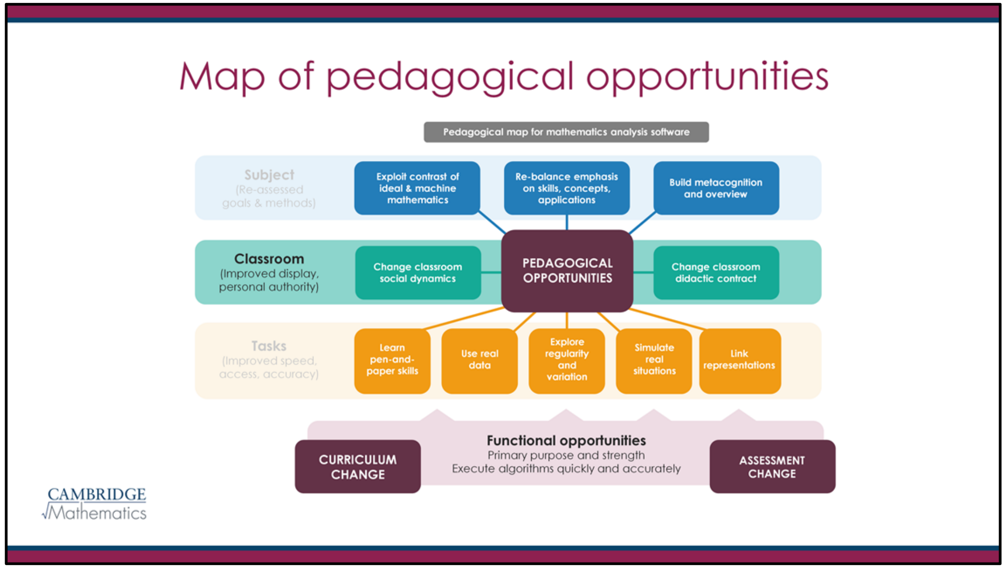
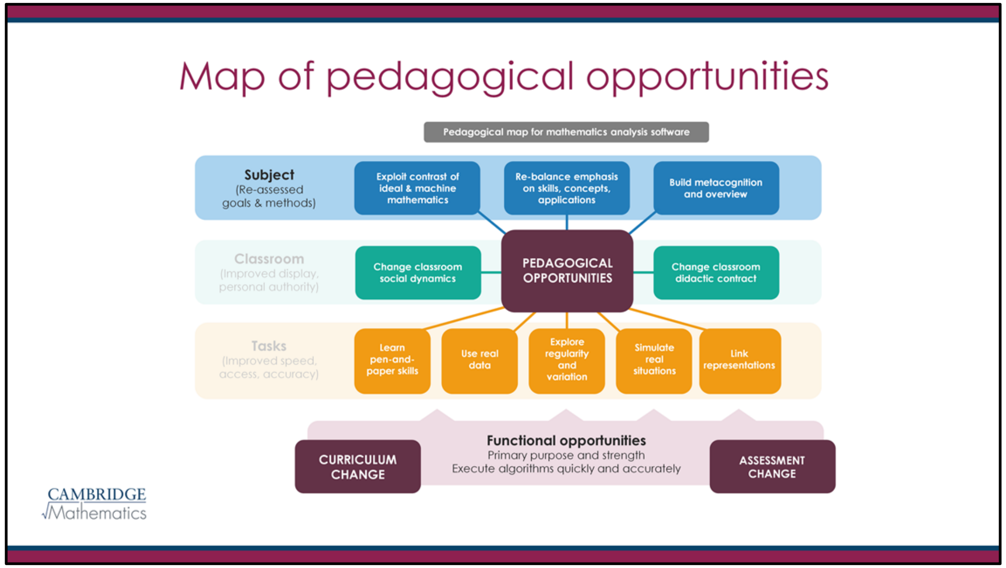


* classroom interactions (using technology to improve the display of mathematical solution processes and support students' collaborative work);



the subject (using technology to support new goals or teaching methods for a mathematics course).

I'll use this map to look at one classroom snapshot.

Classroom snapshot

When will a population of 50,000 bacteria become extinct if the decay rate is 4% per day?

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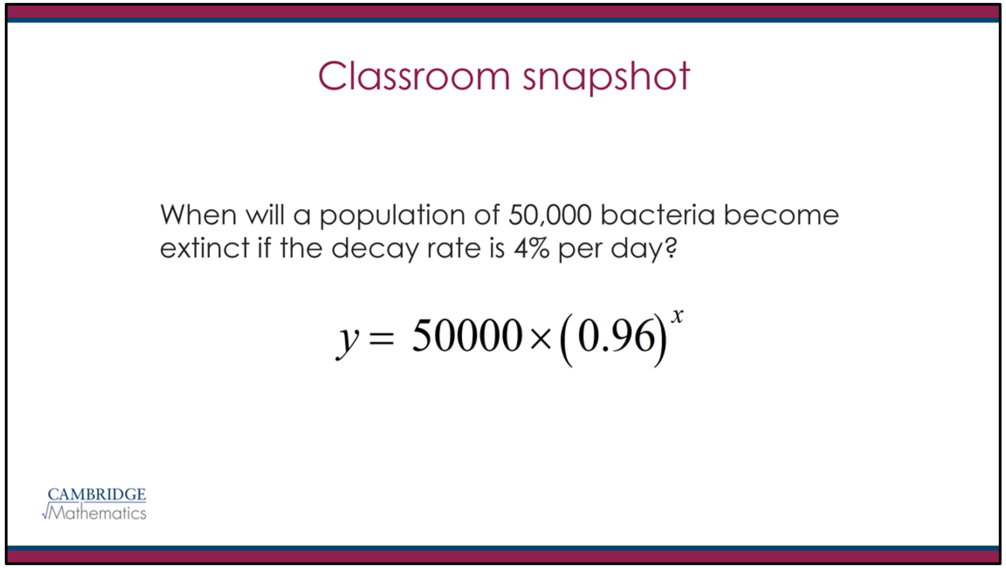
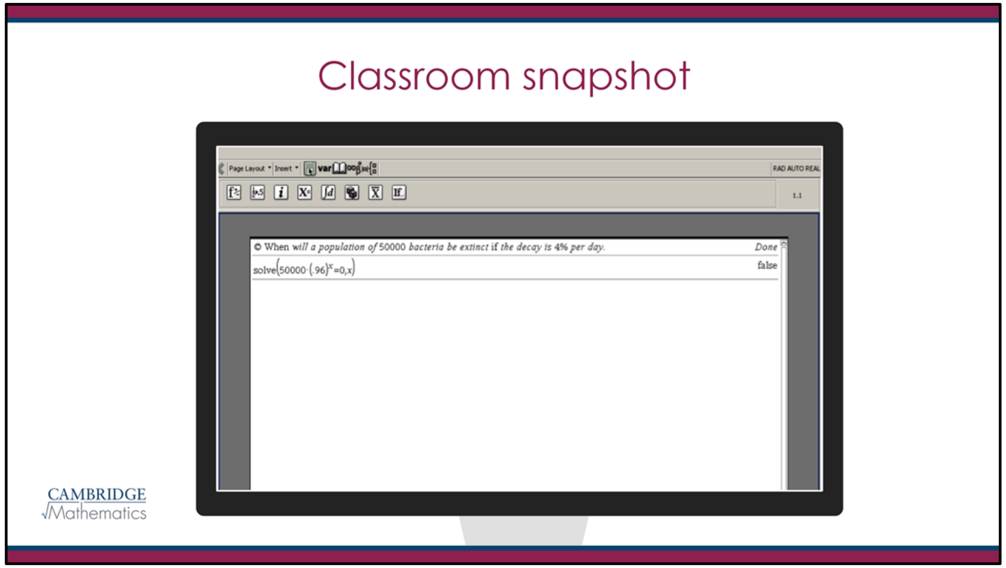
Year 12 students were working with a handheld mathematical analysis device.



One pair of students developed this exponential model for population y at time x.

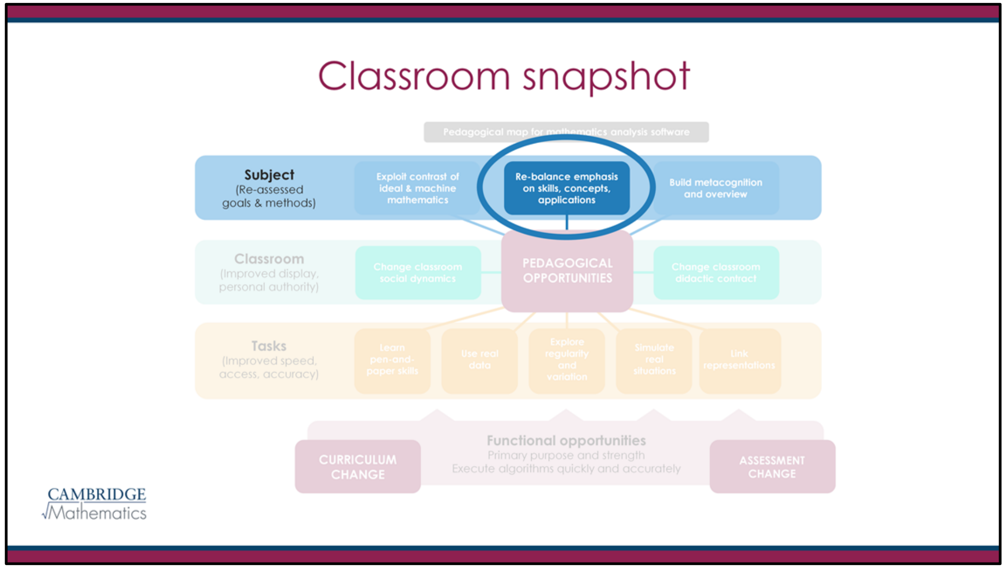
The students then set y = 0 to represent extinction of the population and tried to use their calculator to solve this equation.



But it returned a FALSE message.

The students were initially concerned that this response had been generated because they had made a mistake with the syntax of their command. They re-entered the instruction several times and tried a number of variations to the structure of the command. When the students asked their teacher for assistance, he looked at the display and said that there was nothing wrong with the technical side of what they had done but they should think harder about their assumptions.

After further consideration, and no progress, the teacher directed the problem to the whole class. One student indicated that the difficulty being experienced was because “you can’t have an exponential equal to zero”. This resulted in a whole class discussion of the assumption that extinction meant a population of zero. The discussion identified the reason for the unsatisfactory calculator output as inappropriately equating an exponential model to zero and then considered the possible alternatives. Eventually the class adapted the original assumption to accommodate the limitations of the model by accepting the position that extinction was “any number less than one”. Students then made this adjustment to calculator entry and a satisfactory result was returned.



Using this pedagogical opportunity allowed the teacher to refocus course goals and teaching methods on promoting thinking about the mathematical modelling process rather than on practice of skills.

This snapshot illustrated a kind of pedagogical transformation at the level of the subject. But I don’t think this is where most current research is looking.

In a recent review of research in mathematics education in Australasia from 2012-2015, the chapter on digital technologies devoted 7 pages to published research focusing on new kinds of tasks, 4.5 pages to studies focusing on changing classroom interactions, and 3 pages to studies focusing on how the subject itself could be transformed.

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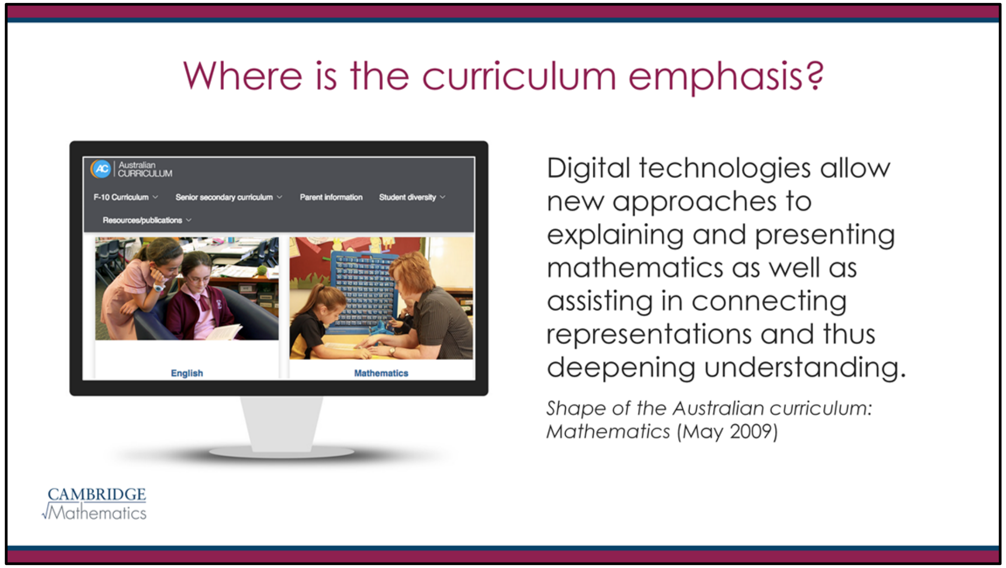
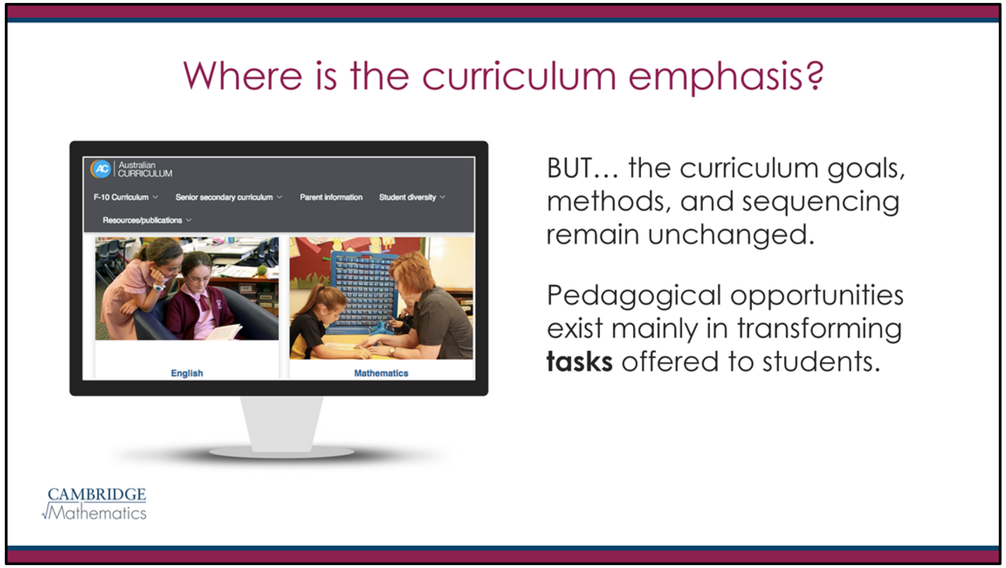
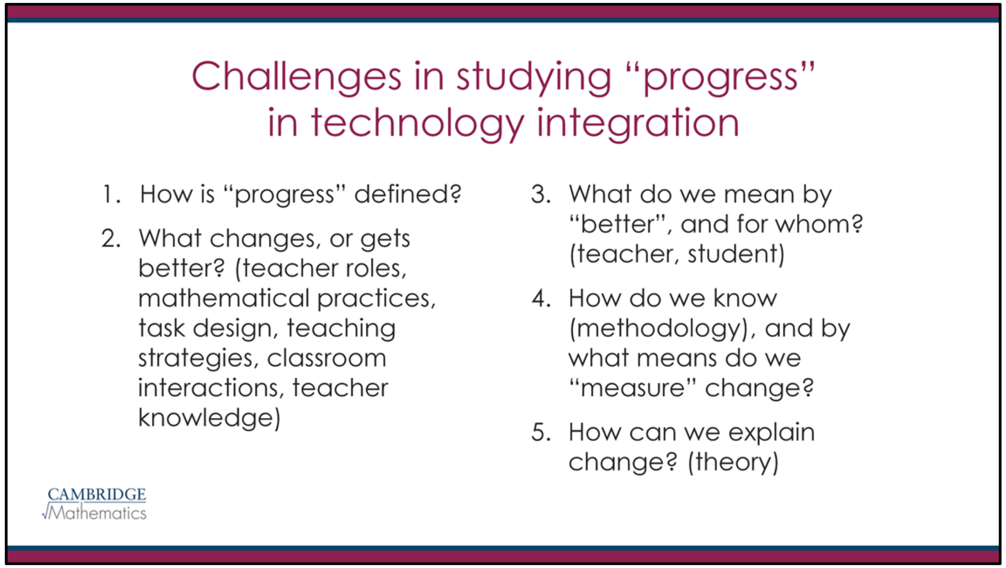


An Australian example: the first nationally consistent curriculum.



Lost opportunity?


Challenges in studying "progress" in technology integration
1. How is "progress" defined?
2. What changes, or gets better? (teacher roles, mathematical practices, task design, teaching strategies, classroom interactions, teacher knowledge)
3. What do we mean by "better", and for whom? (teacher, student)
4. How do we know (methodology), and by what means do we "measure" change?
5. How can we explain change? (theory)
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