Lifting Mathematics Learning for all Learners: Is it possible?

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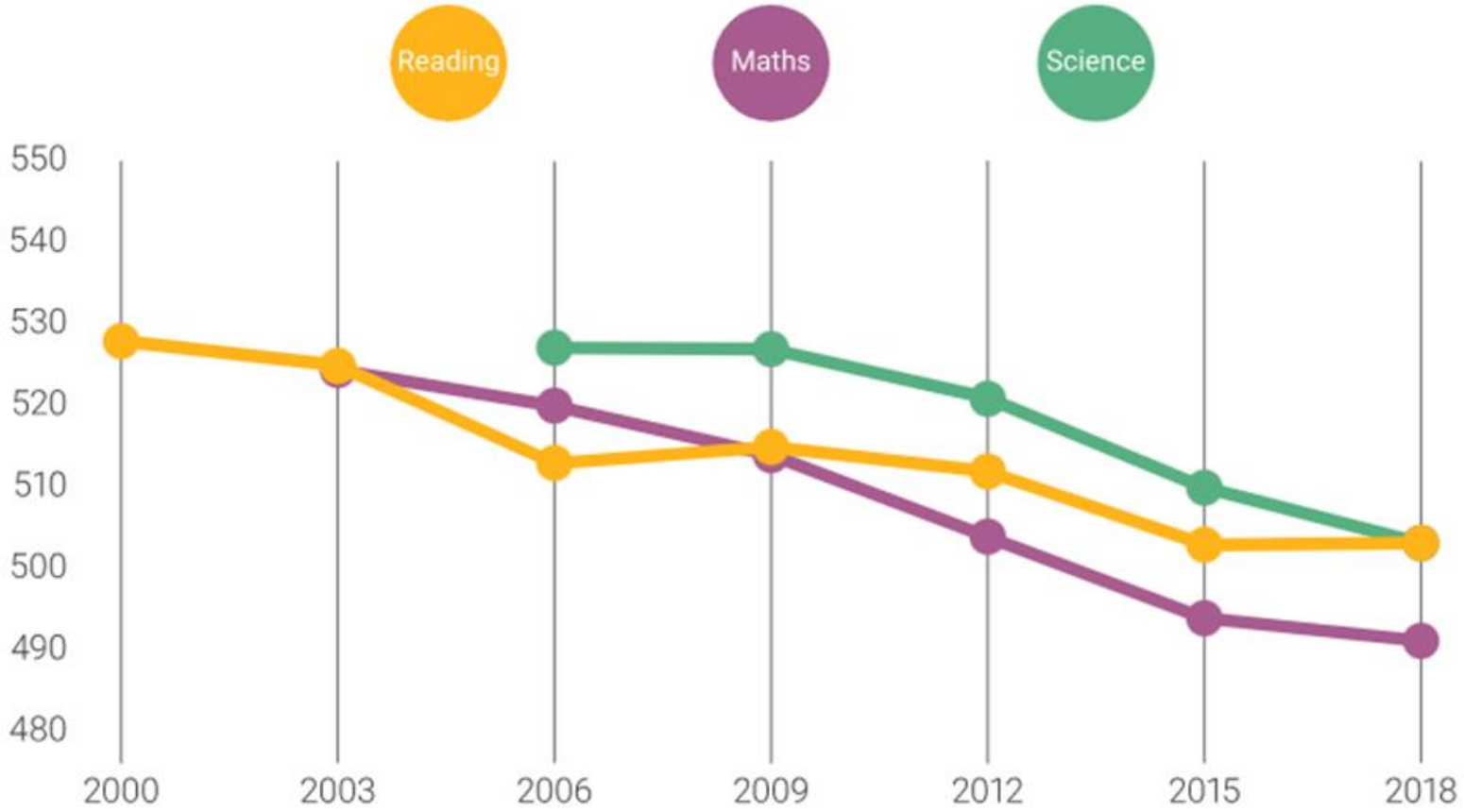
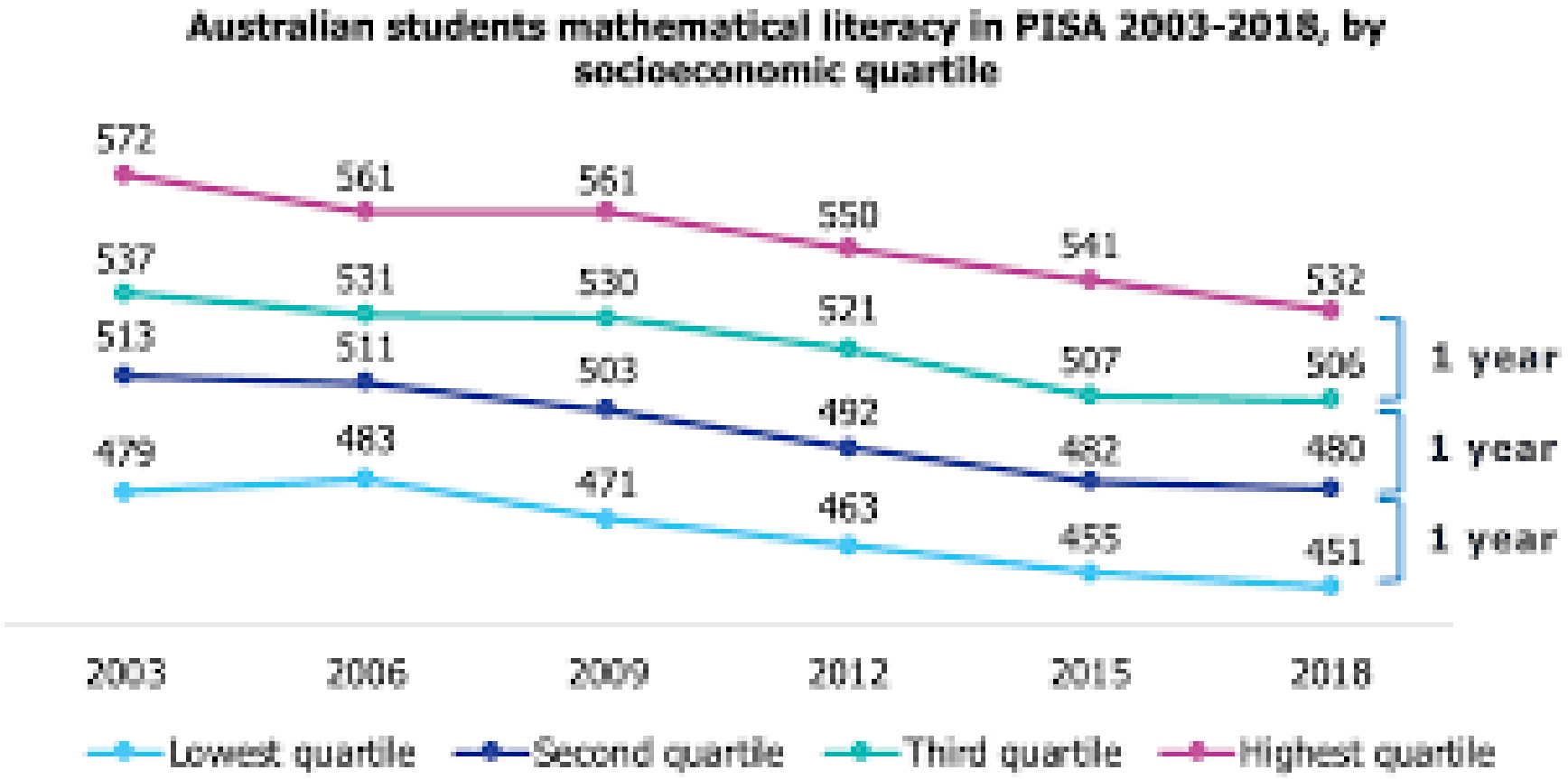
Outline of the talk

- Australia's declining performance in mathematics
- Teacher beliefs
- Distinguishing characteristics of low attainers and high attainers
  - How are they different? Why?
  - How can we support all learners?
- Relevant beliefs of mathematics teachers
- What can you do in your classroom/department/school?

Declining performance in PISA



Socioeconomic quartiles and achievement declines



Within school influences on student performance

- Academic expectations – class and school level
- Student support
- Our own biases/beliefs

Teachers' beliefs

- The nature of mathematics
- Capability of students

"… when teachers have high expectations, believe that students have the ability to learn, and take responsibility for students' learning, students are more engaged, feel more competent while they are learning, learn more, use fewer avoidance strategies when facing difficulties, and perform better" (Archambault et al., 2012, p. 320).

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Individual reflection (5 minutes)

1. Think about the students you teach who most struggle with learning mathematics. How can you tell a student is not good at mathematics?
2. Describe how you ensure these students make progress in mathematics?

Talk to a neighbour or two (7 minutes)

Discuss your individual ideas about:

1. Think about the students you teach who most struggle with learning mathematics. How can you tell a student is not good at mathematics?
2. Describe how you ensure these students make progress in mathematics?

Participants

- 18 teachers (11 males and 7 females) drawn from 6 secondary schools in the same region.
- Teaching experience from 6 weeks to 33 years with 11 reporting fewer than 10 years of experience.
- Six had studied mathematics at university with two of these citing the highest level they had studied as each of 1st, 2nd and 3rd year.
- Eight had studied mathematics to Year 11 or 12 (the final year of secondary school)
- Two reported their highest level of mathematics study as Year 10.
- Six nominated mathematics as their preferred teaching area with other subjects mentioned being Science (7 teachers), Physical Education (3), Geography (1), English/Drama (1), and Early Childhood (1).

Results

- Teachers' responses concerning the characteristics of poor and good mathematics students were classified as:
  - Skills and knowledge
  - Affect
  - Work habits
  - Other

	Poor mathematics students …	Good mathematics students …
Skills and knowledge	have poor *basic computational skills* (7)	are *fluent* with tables (1)
	have poor *understanding* (3)	*understand* concepts (1)
	lack prior knowledge (3)	have broad background knowledge (3)
	have difficulty grasping concepts (2)	can pick up new methods and *explanations* quickly and grasp concepts intuitively (3)
	have no mental strategies (1)	
	are unable to *explain* (1)	are able to *reason and explain* their strategies (2)
	are unable to talk about questions (1)	can respond to questions in class (1)
	can't *transfer* skills to unfamiliar problems (1)	are able to *transfer knowledge to* complex/*unfamiliar contexts* (2)
	require each problem to be broken down into small steps (1)	can *problem solve* (2)
	are very slow to complete tasks (1)	
		can produce *multiple solutions* and *understands* more than one method (4)
		can *justify/prove* their answers (2)
		think outside the box (1)
		are successful (1)
		make few mistakes in written work (1)

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Affect	have negative attitudes/dislike mathematics (4)	have a positive attitude/love maths (2)
	won't try difficult work (3)	
	lack effort (1)	
	are unwilling to complete tasks (1)	want to do maths (1)
	think they can't learn (1)	are self-confident (1)
	lack a desire to learn (1)	are keen to learn, self-motivated (3)
	fear exploring (1)	are willing to explore/takes risks and unafraid of being wrong (3)
	fear algebra (1)	are unafraid of algebra (1)
		stay motivated (2)
		enjoy success (1)
		see the relevance (1)

Work habits	miss lessons (3) are inattentive (1) won’t ask for help (1) only like/do repetitive work with a calculator (1) are disruptive (1) have poor concentration (1)	can help others (1) attempt the hardest problems (1) are willing to listen (1) methodically break down problems, identifies relevant information (2) show working via step-by-step written work (2) take initiative to figure things out, test self (2) are goal setting (2) actively check work (1) are organised (1) make lots of effort in class (1) complete all set work (1) learn from mistakes (1)

Results

- Teachers' responses concerning ways of supporting poor and good mathematics students to make progress were grouped:
  - Affect
  - Tasks considered appropriate
  - Skills
  - Structures

	Poor mathematics students need…	Good mathematics students need…
Affect	to develop confidence (3)	
	praise (1)	
	encouragement (1)	encouragement to work hard, push themselves and continue to learn (1)
	to develop motivation to learn (1)	
	to be taught why mathematics is important and useful (1)	
	success resulting from effort and hopefully leading to better attendance (1)	

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Tasks	(some chance of) success, work that's not too hard (5)	challenging tasks (6)
		open-ended tasks (4) *problem solving* (3)
	tasks that are relevant to their interests (3)	
	tasks at their level (2)	tasks that continue to extend and stretch their knowledge and *understanding* (1)
	applications, real-world relevant tasks (2)	applications (2)
	lots of practical/hands-on (2)	
	engaging tasks to develop confidence (1)	
	easily accessible tasks (1)	
	inclusive tasks (1)	
	the correct steps, correct learning (1)	questions/tasks that provide correct techniques which will enable them to extend themselves (1)
	questions that allow them to show their knowledge without complex formulae (1)	
	tasks designed to move them on from where they currently are (1)	
	work that requires *explanations*, to be asked for verbal *explanations* of how they obtained their answers (1)	lots of opportunity to talk (1) opportunities to *explain* and help others (1)
	applications, real-world relevant tasks (1)	
		logic problems (1)
		lots of *reasoning/understanding problems* with chance to check work (1)
		further development of *reasoning* skills (1)
		extended activities/work to continue when finishes early (1)
		lots of brand new questions (1)

Skills	to continue building number knowledge (1) back to basics (1) to spend time on strategies to improve multiplication *fact recall* (1) to build on basic skills/mental strategies to assist them (1) work on developing memory (1) repetition of essential skills (1)	opportunity to learn new skills rather than revisiting skills already learned (1) to progress skills to the next logical step (1) help *explaining understanding* to other class members (1)

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Structures	one-on-one help (1)	individual questioning to ensure *understanding* of content (1)
	smaller groups with students at the same level (1)	a streamed (same ability) group so working with others who are ‘good’ at maths (1)
	a modified program, keeping them involved in whole class activities but enabling them to access the task (1)	access to the whole curriculum including more demanding coursework (1)
	opportunity to participate and interact with students of different abilities (1)	

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Conclusions

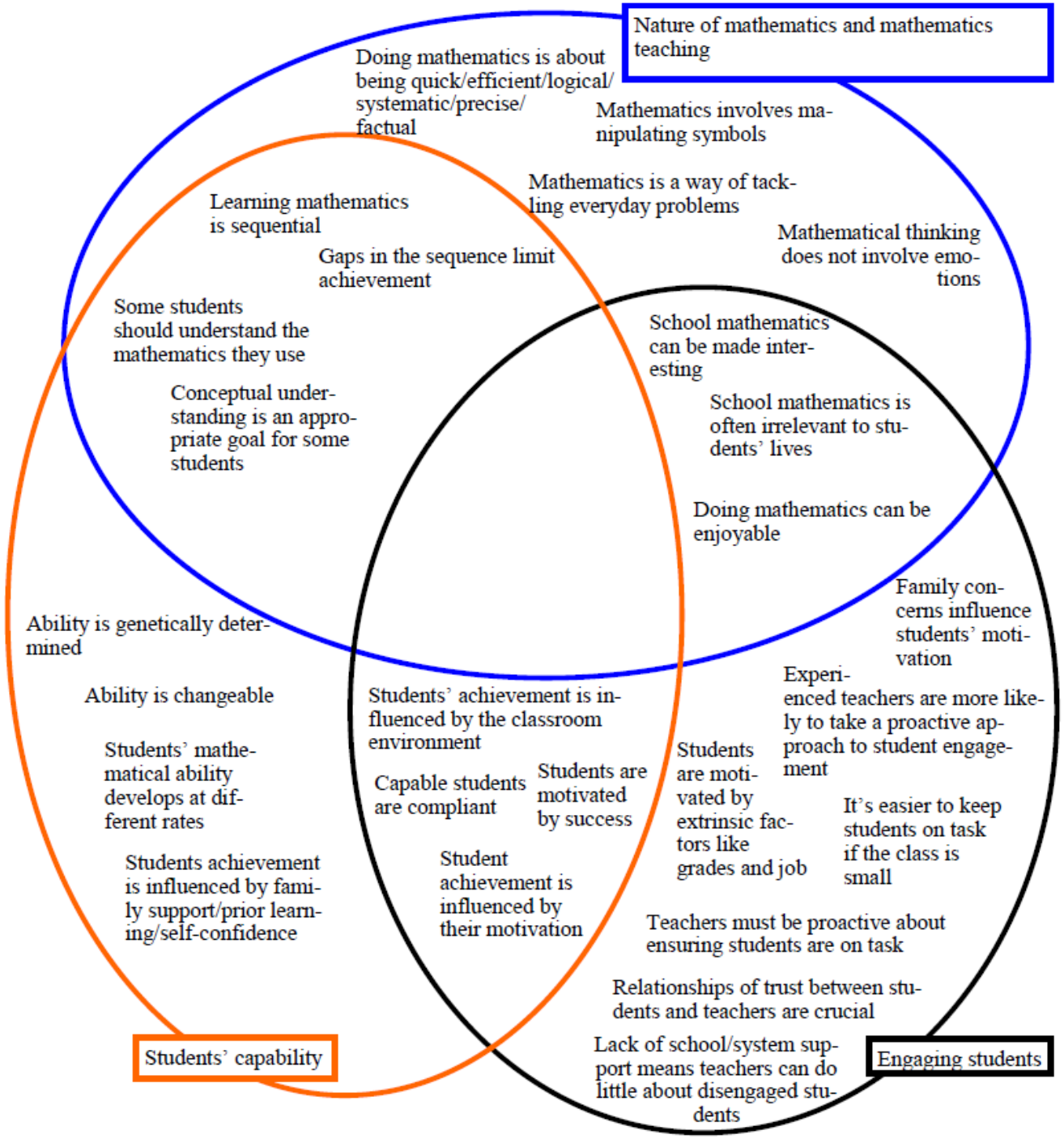
- Poor computational skills seems to be a hallmark of poor mathematics students but interestingly there was only one reference to strong computational skills for ‘good’ students of mathematics
- ‘Good’ students were more likely to be identified by their ability demonstrate aspects of mathematical proficiency

Conclusions

- Teachers believed basic computation to be more important for students who had difficulty learning mathematics, than for other students.
- Teachers may also believe that mathematical proficiency is the province only of ‘good’ mathematics students rather than something that should and can be taught to all students as mandated by the Australian curriculum

Conclusions

- The desire to provide weaker students with tasks that are relevant and that offer the opportunity for success in mathematics is undoubtedly well-meaning but it is unclear what was meant by success.
- It could be assumed that ‘good’ students are successful and hence helping other students to succeed would involve helping them to exhibit the characteristics of ‘good’ students, including being able to demonstrate mathematical proficiency.
- It seems more likely, given the emphasis in these teachers’ responses on basic computational skills, that for ‘poor’ students, success was seen in terms of improving those skills.



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Nature of mathematics and mathematics teaching

Doing mathematics is about being quick/efficient/logical/systematic/precise/factual

Learning mathematics is sequential

Mathematics involves manipulating symbols

Mathematics is a way of tackling everyday problems

Gaps in the sequence limit achievement

Mathematical thinking does not involve emotions

School mathematics can be made interesting

Some students should understand the mathematics they use

Doing mathematics can be enjoyable

Conceptual understanding is an appropriate goal for some students

School mathematics is often irrelevant to students' lives

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Students' capability

Learning mathematics is sequential

Gaps in the sequence limit achievement

Some students should understand the mathematics they use

Conceptual understanding is an appropriate goal for some students

Students' achievement is influenced by the classroom environment

Ability is genetically determined

Ability is changeable

Capable students are compliant

Students' mathematical ability develops at different rates

Student achievement is influenced by their motivation

Students are motivated by success

Student' achievement is influenced by family support/prior learning/self-confidence

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School mathematics can be made interesting

School mathematics is often irrelevant to students' lives

Students' achievement is influenced by the classroom environment

Doing mathematics can be enjoyable

Family concerns influence students' motivation

Experienced teachers are more likely to take a proactive approach to student engagement

Students are motivated by extrinsic factors like grades and job prospects

Capable students are compliant

Students are motivated by success

Teachers must be proactive about ensuring students are on task

Student achievement is influenced by their motivation

Relationships of trust between students and teachers are crucial

Lack of school/system support means teachers can do little about disengaged students

It's easier to keep students on task if the class is small

Engaging students

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How can we lift mathematics learning for all students?

- Teacher beliefs are key as they underpin what teachers do
- Provoke frank discussion of whether low attainers can be taught to be more like high attainers
  - Is mathematics ability malleable?

How can we lift mathematics learning for all students?

- Run an activity like the one we did earlier
- Present sets of beliefs from other teachers and discuss which resonate or make sense and why
- What would teaching of low attainers look like if we believed they could learn to be high attainers?
  - How can we teach students to reason, justify their solutions, make connections among concepts …
- Is mastery of basic facts necessary before learning more “advanced” topics e.g., algebra?

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Interested in exploring equitable differentiation?

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