KEYNOTE

Karmel Oration
Excellent progress for all: A function of year-level curriculum or evidenced-based learning progressions?

Professor Dianne Siemon
RMIT University

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Dianne Siemon is an Emeritus Professor at RMIT University. From 2014 to 2018, Di led the Reframing Mathematical Futures II research team that worked with 32 secondary schools nationally to develop evidenced-based learning progressions for algebraic, geometrical and statistical reasoning in the middle years. The project also produced validated assessment tools and targeted teaching advice to help identify and scaffold students' learning in relation to the progressions.

Di has been involved in pre-service mathematics education for over 30 years and remains actively involved in the professional development of practising teachers, particularly in relation to the development of the 'big ideas' in Number and the use of rich assessment tasks to inform teaching. Di has directed a number of other large-scale research projects including Building Community Capital to Support Sustainable Numeracy Education in Remote Locations (2006–2009), Scaffolding Numeracy in the Middle Years (2003–2006), Researching Numeracy Teaching Approaches in Primary Schools (2001–2003), and the Middle Years Numeracy Research (1999–2001). Di is a life member of the Australian Association of Mathematics Teachers and the Mathematical Association of Victoria.

Abstract

Excellent progress for all students is an ambitious but necessary goal if we are to improve the life choices of all students. At the moment, we are not serving all our students well despite the best efforts of teachers. We need to look further afield to the curriculum and assessment regimes that drive current practice. Grouping students by ability and offering a watered-down curriculum for some is not the answer. Evidenced-based learning progressions that point to what is important in ensuring all students build a deep, well-connected understanding of mathematics over time is what is needed to support reform at scale. Where the evidenced-based tools and resources produced by this type of research are used to identify and respond to student learning needs in relation to what is important, it has been shown to make a significant difference to student outcomes and engagement. Adopting a targeted teaching approach means that not everything has to be differentiated and not everything needs to be considered as often or to the same depth. Time can be spent researching challenging but accessible tasks and developing a culture that supports and rewards persistence, effort and a growth mind-set.

Introduction

Excellent progress for every student is the ultimate goal of all those involved in education. However, the continuing decline in Australian students' performance on international assessments of mathematical literacy (Thomson et al., 2019, 2020), and concern about the continuing decline in the number of students able and willing to undertake the more advanced mathematics subjects in the final years of secondary school (Wienk, 2020), suggest that while some students are doing very well, schools are not supporting *all students* to make excellent progress in mathematics.

There is 'long tail' of students who may be up to seven years behind their higher achieving peers in curriculum terms (Masters, 2013; Siemon & Virgona, 2001), and who disproportionally come from disadvantaged or lower socio-economic backgrounds (Thomson, 2021). This is inequitable in a country that prides itself on a fair go for all and aspires to 'excellent progress for all students'.

There are many reasons for this state of affairs, but an important one is the expectation that all students, irrespective of where they are in their particular learning journey, should attempt to master all aspects of the mathematics curriculum at their year level. This situation is exacerbated by the fact that school mathematics tends to be presented as a set of disconnected skills to be demonstrated and practised rather than explored and discussed, with little or no indication of what aspects of mathematics are more important than others in progressing students' mathematics learning (Siemon et al., 2012).

This raises the important question of what constitutes excellent progress. One view of what this might involve is given in the Gonski-led *Review to achieve educational excellence in Australian schools* – that we should aspire to 'Deliver at least one year's growth in learning for every student every year' (Department of Education and Training, 2018, p. x). But my question is, 'growth in relation to what?' Is it in relation to all aspects of the year-level curriculum, or what learning progression research suggests are the key ideas needed to sustain and support further learning in mathematics?

If a *years' growth* is defined in terms of year-level curriculum, it serves to maintain the status quo. For example, a Year 4 student who is five or so years behind their high-achieving peers, will still be five or more years behind their high achieving peers in Year 8 even if they have all achieved at least one year's growth in all of the intervening years. This is not excellent progress. Accepting the status quo or considering alternatives to 'presenting the curriculum in year-level packages' (Masters, 2017, p. 2) risks entrenching the practice of ability grouping, which is known to have a negative impact on student learning, self-esteem and confidence, and reproduce social inequality (e.g. Boaler & Staples, 2008; Francis, 2019).

Another problem with the Gonski view is that 'at least' suggests something a bit more than one year's growth rather than a lot more. We can and should be aspiring to deliver whatever it takes to ensure all students have the opportunity to engage productively with the curriculum at their year level or beyond. Teaching all aspects of the curriculum and grouping by ability is not the answer. Identifying where students are in relation to important mathematics and focusing on what is known to make a difference through targeted teaching and creative mixed ability teaching is what is needed (e.g. Breed, 2011; Goss et al., 2015; Siemon, Banks, & Prasad, 2018; Sullivan, 2011). And this is where research-based learning progressions/trajectories (LP/Ts) like the ones we have developed for multiplicative thinking (Siemon et al., 2006; Siemon, 2019) and mathematical reasoning (Siemon, Callingham, et al., 2018; Siemon et al., 2019) can contribute.

In recent years, attention has turned to the development of evidenced-based LP/Ts as a means of identifying what mathematics is important in ensuring students build a deep, well connected understanding of mathematics over time (e.g. Confrey et al., 2014; Siemon et al., 2006, 2019). Typically, this work also provides assessment tools to identify where learners are in their mathematics learning journey, and instructional materials and/or teaching advice aimed at progressing that journey from naïve to more sophisticated understandings.

What differentiates this work from the sort of progressions derived from the analysis of large data sets, such as NAPLAN, is that it is independent of the curriculum. The purpose of LP/T research is to identify and test ordered networks of key ideas and strategies rather than determine where students might be in relation to the curriculum. LP/T research starts out with an extensive review of the literature in a particular field to identify key ideas and establish a hypothetical learning trajectory. Assessment tasks are devised and trialled to test the hypothetical trajectory, and the results analysed using Rasch analysis (Bond & Fox, 2015), which allows item difficulty and student performance to be measured by the same unit and placed jointly on a single scale. This approach supports inferences about what students located at roughly the same points on the scale are able to do and what is likely to be within their grasp with teaching targeted to learning need, as detailed analyses of items located at similar points on the scale can be used to develop teaching advice about where to go to next.

In developing the LP/Ts for multiplicative thinking and mathematical reasoning, rich assessment tasks and partial credit scoring rubrics (Masters, 1982) were used to identify qualitative differences in students thinking, and to identify the 'big ideas' without which progress in these domains would be impacted. For multiplicative thinking, this work resulted in two assessment options that can be used to monitor students' growth over time on the same scale, and an evidenced-based LP/T that includes targeted teaching advice in the form of the *Learning assessment framework for multiplicative thinking* (LAF).[1] For mathematical reasoning, the research resulted in four assessment options for each area of mathematical reasoning (i.e. algebraic, geometrical, and statistical reasoning) and evidenced-based LP/Ts and targeted teaching advice for each area.[2]

Taken together these resources provide a basis for teachers 'to make decisions about the next steps in instruction that are likely to be better, or better founded than, the decisions they would have been made in the absence of that evidence' (Wiliam, 2011, p. 43). Understood and enacted in this way, research-based LP/Ts can sit alongside mandated curricula to help teachers identify where students are and where to go to next in relation to important mathematics. In addition, by pointing to what is critical in progressing students' mathematics learning *over time*, research-based LP/Ts can also be used to identify key stages in schooling by which certain big ideas need to be in place in order to support further mathematics learning. Prioritising these in planning is essential in preventing the mathematics achievement gap from widening the longer students spend in school. Targeted teaching has been found to progress students' mathematics learning by much more than one year's growth in less than a year (e.g. Breed, 2011; Siemon, 2017, Siemon et al., 2018a). It's not rocket science – focusing on those things that have been shown to make a difference, will make a difference.

Conclusion

Excellent progress for every student is an ambitious goal, but it will not be achieved by expecting all students in a particular year level to demonstrate every one of the content descriptors at that level at the same time in the same way. Neither is it an either/or situation as suggested by Gonski (Department of Education and Training. 2018). Evidenced-based LP/Ts that point to the 'big ideas' of mathematics, the connections between them, and their likely development over time, can help teachers better navigate the curriculum by pointing to what mathematics is important. This means that not everything needs to be differentiated and not everything needs to be considered as often or to the same depth. By providing valid assessment tools that identify where students are in relation to what is important, starting points for teaching can be identified; and by providing targeted teaching advice to support teachers to address student learning in relation to what is important, we can

1 https://www.education.vic.gov.au/school/teachers/teachingresources/discipline/maths/assessment/Pages/scaffoldnum.aspx
2 http://www.mathseducation.org.au/online-resources/introducing-the-rmfii-resources/

work towards excellent progress for all students. This will not be easy, but effective teaching never is. There is no single way to implement a targeted teaching approach and while some approaches appear to be better than others, successful implementation depends very much on the good will and commitment of all those involved, particularly school leadership.

References

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of Railside School, *Teachers College Record*, *110*(3), 608–645.

Bond, T., & Fox, C. (2015). Applying the Rasch model: Fundamental measurement in the human sciences (3rd ed.). Lawrence Erlbaum Associates

Breed, M. (2011). Constructing paths to multiplicative thinking [Unpublished doctoral dissertation]. RMIT University.

Confrey, J., Maloney, A., Nguyen, K., & Rupp, A. (2014). Equipartitioning, A foundation for rational number reasoning: Elucidation of a learning trajectory. In A. P. Maloney, J. Confrey, & K. H. Nguyen (Eds.), *Learning over time: Learning trajectories in mathematics education* (pp. 61–96). Information Age Publishing.

Department of Education and Training. (2018). *Through growth to achievement: Report of the Review to Achieve Educational Excellence in Australian Schools.* Commonwealth of Australia. https://www.dese.gov.au/quality-schools-package/resources/through-growth-achievement-report-review-achieve-educational-excellence-australian-schools

Francis, B., (2019). Re-assessing 'ability' grouping. Improving practice for equity and attainment. Taylor Francis Group.

Goss, P., Hunter, J., Romanes, D., & Parsonage, H. (2015). *Targeted teaching: How better use of data can improve student learning*. Grattan Institute.

Masters, G. (1982). A Rasch model for partial credit modelling. *Psychometrika*, *47*, 149–174. https://doi.org/10.1007/978-1-4757-2691-6_6

Masters, G. (2013). Reforming educational assessment: Imperatives, principles and challenges. *Australian Education Review*. https://research.acer.edu.au/cgi/viewcontent.cgi?article=1021&context=aer

Masters, G. (2017). *Lifting achievement levels and improving the return on Australia's investment in schooling. Submission to the Review to Achieve Educational Excellence in Australian Schools*. Australian Council for Educational Research. https://research.acer.edu.au/policy_analysis_misc/27

Siemon, D. (2017, 27 Feb.). Targeting the big ideas in mathematics. *Teacher.* https://www.teachermagazine.com/au_en/articles/targeting-big-ideas-in-mathematics

Siemon, D. (2019). Knowing and building on what students know: The case of multiplicative thinking. In D. Siemon, T. Barkatsas & R. Seah (Eds.), *Researching and using progressions (trajectories) in mathematics education* (pp. 6–31). Brill-Sense.

Siemon, D., Banks, N., & Prasad, S. (2018). Multiplicative thinking a STEM foundation. In T. Barkatsas, N. Carr, & G. Cooper (Ed.), *STEM education: An emerging field of inquiry*. Sense Publications.

Siemon, D., Barkatsas, T., & Seah, R. (Eds.) (2019). *Researching and using progressions (trajectories) in mathematics education*. Brill-Sense.

Siemon, D., Breed, M., Dole, S., Izard, J., & Virgona J. (2006). *Scaffolding numeracy in the middle years – Project findings, materials and resources, Final report*. https://www.education.vic.gov.au/school/teachers/teachingresources/discipline/maths/assessment/Pages/scaffoldnum.aspx

Siemon, D., Bleckly, J., & Neal, D. (2012). Working with the big ideas in number and the Australian Curriculum Mathematics. In W. Atweh, M. Goos, R Jorgensen & D. Siemon (Eds.) *Engaging the Australian Curriculum Mathematics – Perspectives from the field* (pp. 19–46). Mathematical Education Research Group of Australasia

Siemon, D., Callingham, R., Day, L., Horne, M., Seah, R., Stephens, M., & Watson, J. (2018). From research to practice: The case of mathematical reasoning. In J. Hunter, L. Darragh & P. Perger (Eds.), *Making waves, opening spaces, Proceedings of the 41st annual conference of the Mathematics Education Research Group of Australasia* (pp. 40–49). MERGA. https://merga.net.au/common/Uploaded%20files/Annual%20Conference%20Proceedings/2018%20CP%20Short%20communications/MERGA%20Book.pdf

Siemon, D., & Virgona, J. (2001). Roadmaps to numeracy – Reflections on the Middle Years Numeracy Research Project. *Proceedings of the Annual Conference of the Australian Association for Research in Education*, Fremantle.

Sullivan, P. (2011). *Teaching mathematics using research-informed strategies*. Australian Council for Educational Research.

Thomson, S. (2021). *Australia: PISA Australia – Excellence and equity?* ACER. https://research.acer.edu.au/ozpisa/51/

Thomson, S., De Bortoli, L., Underwood, C., & Schmid, M. (2019). PISA 2018: *Reporting Australia's results. Volume I student performance*. https://research.acer.edu.au/ozpisa/35/

Thomson, S., Wernert, N., Rodrigues, S., & O'Grady, E. (2020). *TIMSS 2019 Australia. Volume I: Student performance*. https://research.acer.edu.au/timss_2019/2/

Wienk, M. (2020). *The state of the mathematical sciences 2020*. AMSI. https://amsi.org.au/wp-content/uploads/2020/05/amsi-discipline-profile-2020.pdf

Wiliam, D. (2011). *Embedded formative assessment*. Solution Tree Press.