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Commentaries

Challenges in Teaching Mathematics: Perspectives From Students' Learning Difficulties

Reflections on 'Challenges in Mathematical Cognition' by Alcock et al. (2016)

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Abstract

Alcock et al (2016, this issue) have set out and discussed a potential research agenda for mathematical cognition. It is timely that research topics, along with knowledge uncovered to date, should be incorporated into a coordinated agenda for further research. This commentary focuses on the perspectives that learning difficulties, and dyscalculia, reveal. These perspectives potentially add much to that research agenda. [Commentary on: Alcock, L., Ansari, D., Batchelor, S., Bisson, M.-J., De Smedt, B., Gilmore, C., . . . Weber, K. (2016). Challenges in mathematical cognition: A collaboratively-derived research agenda. Journal of Numerical Cognition, 2, 20-41. doi:10.5964/jnc.v2i1.10]

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Alcock et al. (2016, this issue) emphasize the diversity of backgrounds and approaches with respect to their contributors. They also make reference to the contributors' career trajectories. With that in mind I feel comfortable being open and making a claim that I am able to comment objectively on this paper as I am well past being an 'early- to mid-term academic'. I consider my background is relevant as, indeed, are the backgrounds of the contributors to the "Challenges" project (Alcock et al., 2016, this issue) I taught students with specific learning difficulties in maths for over twenty years, have researched and written about the issues for some thirty years, for example, Bath, Chinn, and Knox (1986), and have lectured and trained teachers and educators from more than thirty countries worldwide. Consequently, my informal data bank, acquired by asking thousands of those teachers and educators for their evaluations and opinions of the issues in learning mathematics, is very large and diverse.

The time for generating a coherent agenda for research on mathematical cognition is long overdue. Problems with learning maths are international and often subject to deeply entrenched beliefs, for example, that all children can rote learn all times table facts and cultures, for example, that mental arithmetic should be executed rapidly, that handicap the learning of maths for dyscalculic students and many others much higher on the learning spectrum.

As this problem is worldwide, it is surprising to find that there are no contributors to this Challenge from, for example, India, Asia, Israel, Australia or New Zealand. However, I am sure that expertise in dyscalculia and maths learning difficulties will be comprehensively represented among the researchers. I firmly believe there is much to be learned from the ‘outliers’, the students who perform at the extremes of the normal distribution (echoing here Murray, Hillaire, Johnson, & Rappolt-Schlitmann, 2015) that will inform research into the mathematical cognition of all learners. There is a spectrum of difficulties in learning maths, due to the heterogeneity of learners and the constellation of skills that maths requires of those learners (Zhou & Cheng, 2015).

I shall base my commentary and observations on the research and wisdom of the 63 authors who, between them, wrote 31 chapters for ‘The Routledge International Handbook of Dyscalculia and Mathematical Learning Difficulties’. I compiled and edited the Handbook which was published in 2015.

For the Introduction in the Handbook I identified and discussed 16 key questions pertinent to learning difficulties in maths, relating each question to the contributions from the Handbook authors. The learning difficulties spectrum can provide new perspectives on old problems. For example, two of the research questions from the 26 listed by Alcock et al. (2016) concern fluency in basic facts and automatic access to useful mathematical knowledge *while still promoting understanding of the underlying concepts.* If I interpret automatic and fluency as instant retrieval from memory then these are key areas of difficulty identified by many researchers studying dyscalculia and maths learning difficulties (for example, Geary, 2004). It is the phrase *while still promoting understanding of the underlying concepts* that caught my attention. Working with children who have difficulties with maths tells us that it is the focus on developing understanding that should precede the focus on retrieval. Bugden and Ansari’s (2015) work in neuroscience may one day identify why so many children find retrieval so very difficult. Until then we are left with the belief that all children can accomplish this task if they just work at it for long enough, thus attributing the responsibility to them.

There are many observations on early learning in the Handbook, ranging from Ho, Wong, and Chan (2015) writing about 3-year-old children learning how to process 2-digit plus 2-digit computations in Kindergarten in Hong Kong to Ramaa (2015) writing about first generation learners in India. Whatever the country or the experience, I am mindful of early research on the power of the first learning experience (Buswell & Judd, 1925), whether that experience is right or wrong, and its cognitive dominance, an observation echoed by Key Finding 1 from the National Research Council’s book, ‘How People Learn’ (Bransford, Brown, & Cocking, 2000).

Amongst the observations about early learning experiences from the Handbook, I hope that those involved in early education take note of the gentle advice on using story telling (MacGrath, 2015) as a low stress way of developing a sense and enjoyment of number in young children. Complementing this, Zhou and Cheng (2015) talk of the role of imagination in developing mathematical reasoning. I am concerned that many children give up on maths at a young age, another observation from my informal data base.

At the base of early learning in terms of developmental trajectories is an understanding of place value (Ho et al., 2015). In addressing the developmental trajectories of this vital concept teachers often forget to track back to the foundations of mathematics.

Section E of the Alcock et al. (2016) paper, focusing on intervention, is key to progress in mathematics education, but obviously has to be founded on a knowledge of why and how children learn or fail to learn, hence the earlier sections. It seems to me that interventions and pedagogy, particularly in England, are rarely based on an understanding of the concepts of maths that the Challenge is seeking to put in place. From a learning difficulties perspective, it may be useful to consider the role played by inclusion and differentiation in the classroom, which is often significant and should influence pedagogy.

A key influence in my early days in the field was Ashlock's (1982) work on error patterns and thus the use of a diagnostic approach to teaching. Teaching should be a responsive and reflective activity suggesting that templates for a successful lesson are unlikely to be successful. The identification of 26 key research issues may sound like a generous number of questions to some, but the complexity of these issues suggests to me that that is not the case.

Finally, I often revisit Krutetskii's (1976) criteria for success in mathematics. I would wish to consider success in maths from more than just a learning difficulties perspective. They are succinct and pertinent for all learners and teachers and dovetail comfortably into the goals of this admirable project. I end by quoting his criteria:

> - The ability for logical thought in the sphere of quantitative and spatial relationships, number and letter symbols; the ability to think in mathematical symbols.
> - The ability for rapid and broad generalisation of mathematical objects, relations and operations.
> - Flexibility of mental processes in mathematical activity.
> - Striving for clarity, simplicity, economy and rationality of solutions.
> - The ability for rapid and free reconstruction of the direction of a mental process, switching from a direct to a reverse train of thought.
> - Mathematical memory (generalised memory for mathematical relationships), and for methods of problem solving and principles of approach.
>
> These components are closely interrelated, influencing one another and forming in their aggregate a single integral syndrome of mathematical giftedness. (pp. 87-88)

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