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Mathematical Resilience

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Background

Many people find it difficult to take part in mathematical learning, to the point that they exhibit phobia or anxiety, or at least avoidance from engaging in any activity that could require mathematical reasoning. Literature relating to recovering from adverse conditions and abuse has been helpful in understanding the source of these difficulties. In collecting stories from some cases of people with mathematics phobia, and reading related literature, we have come to see what happens to many people in relation to mathematics as cognitive (mathematical) abuse. We have defined a construct we call **mathematical resilience** (Johnston-Wilder and Lee 2008) by which we mean a positive adaptation that allows people to overcome barriers presented when learning mathematics.

Both psychological resilience (e.g. Newman 2004) and mathematics anxiety (e.g. Ashcraft 2002) are well documented and have associated measurement systems. In this paper, we discuss the characteristics of **mathematical resilience** and the ways in which using this construct can help overcome current negative attitudes to mathematics. The evidence shows mathematical resilience can be developed in learners with the involvement of all teachers, including non-specialists.

Research Questions

The research question is 'How can we work within schools to enable all the adults to build mathematical resilience in their learners?' Hence the enquiry is focused on how mathematical resilience might be recognised, developed and measured in learners of mathematics and how our ways of working with the school can contribute to this development.

Methods

We use the term 'mathematical resilience' to name that quality by which some learners approach mathematics with confidence, persistence and a willingness to discuss, reflect and research. All learning requires resilience; we contend that the resilience required for learning mathematics ('mathematical resilience') is a particular construct as a consequence of various factors including: the type of teaching often used (Nardi & Steward 2003), the nature of mathematics itself (Jaworski 2010) and pervasive beliefs about mathematical ability being 'fixed' (Dweck 1999). Helping learners to develop mathematical resilience enables them to adapt positively to the difficulties presented by mathematics and to be in a position to consider continuing to develop their mathematics beyond compulsory age.

Developing mathematical resilience currently happens by accident if it happens at all. The study is a thick description of a deliberate effort to increase the mathematical resilience of the pupils at one school. We worked with the staff to build a mathematically supportive community for example we recruited mathematics coaches with no strong mathematical knowledge of their own, but with willingness to sit alongside learners and face their mathematical demons together.

Frame

Many learners experience the process of learning mathematics as a process of facing severe adversity; in this sense, mathematical resilience is a positive adaptation to enable success. (Newman 2004). If learners are to engage with mathematics, struggle through problems, deal with barriers and misunderstandings and work on mathematical ideas, then they need mathematical resilience. In the UK, many people become anxious about mathematics. Mathematics anxiety severely compromises

the ability to carry out mathematical processes and is, for many, an acquired response to school situations rather than being innate (Ashcraft 2002). The origins of mathematics anxiety lie in part in the interactions between learner and teacher (Ashcraft, 2002). There is an indication that articulation of ideas improves learners' confidence in both their learning and their competence to use mathematical concepts; that is, it increases their mathematical resilience.

Speaking or otherwise communicating is an important part of developing mathematical resilience; becoming able to articulate mathematical ideas, concepts and reasoning has a profound effect on the way that learners see themselves (e.g. Lee 2006, Mercer and Littleton 2007). An individual takes on the identity of a mathematician (Holland et al. 1998) by learning how to talk like a mathematician. Giving learners the opportunity to 'talk like a mathematician' means that they become someone who 'knows and can do mathematics'; that is, they become mathematically resilient.

The current system of teaching and testing seems to develop in learners an entity or fixed theory of learning (Dweck 1999) that makes them believe that they are either good at mathematics or they are not. Even those who see themselves as being good at mathematics when at school may not develop mathematical resilience as every time they get stuck they ask their teacher, who 'smoothes the path' (Wigley 1992) for them. They may not meet problems that require 'struggle' and therefore may not develop ways to deal with adversity.

Research findings

By naming and defining the construct of 'mathematical resilience', we argue that teachers and policy makers will be enabled to develop it and to measure how successful they have been in enabling their learners to become mathematically resilient.

The tools we used to measure mathematical resilience showed that the learners became more aware of their own learning and better able to continue the struggle to understand and know mathematics. Further, the process of naming 'mathematical resilience' gave non-mathematics specialists access to ways of supporting the learners. We recruited the whole school in the endeavour to think about and talk about mathematical learning and to become a mathematically resilient school. In this paper we discuss the results.

This is a thick description of a journey towards involving the whole school in 'the mathematics problem' over one academic year - the journey continues.

References

Ashcraft, M. H. (2002) Math Anxiety: Personal, Educational, and Cognitive Consequences. *Current Directions in Psychological Science*, 11(5) 181-185.

Dweck, C. S. (1999) *Self-Theories: Their role in motivation, personality, and development*. Philadelphia, PA: The Psychology Press.

Holland, D., Skinner, D., Lachicotte, W. & Cain, C. (1998) *Identity and agency in Cultural Worlds.* Cambridge, Mass.: Harvard University Press.

Jaworski, B. (2010) Mathematics - Joy and Rigour. In Johnston-Wilder S and Lee, C. (Eds) *Leading Practice and Managing Change in the Mathematics Department.* St Albans: Tarquin Publications. pp 15-32.

Johnston-Wilder, S. & Lee, C. (2008) Does Articulation Matter when Learning Mathematics? In Joubert, M. (Ed.) *Proceedings of the British Society for Research into Learning Mathematics*, 28(3). pp 54-59.

Lee, C. (2006) *Language for Learning Mathematics- assessment for learning in practice.* Buckingham: Open University Press.

Mercer, N. & Littleton, K. (2007) *Dialogue and the Development of Children's thinking.* London: Routledge.

Nardi, E. & Steward, S. (2003) Is Mathematics T.I.R.E.D? A Profile of Quiet Disaffection in the Secondary Mathematics Classroom. *British Education Research Journal,* (29)3. pp 345-367.

Newman, T. (2004) *What Works in Building Resilience?* London: Barnardo's.

Wigley, A. (1992) Models for teaching mathematics. *Mathematics Teaching,* 141.