# Building mathematical resilience: A case study of grade three children experiencing mathematics anxiety in Kenya

Njaru Mbogo

Mathematical resilience defined as a positive adaptive stance to mathematics allows children to function optimally in a mathematics lesson. Therefore, children experiencing mathematics anxiety require mathematical resilience to aid optimal mathematics functioning in a mathematics lesson. Interestingly, mathematics anxiety research focuses on maladaptive responses to learning mathematics. Against this background this proposed PhD study contends that the mathematical resilience grade three children with mathematics anxiety require to aid optimal mathematics functioning in a mathematics lesson is a consequence of various attributes including daily classroom instructional strategy, the nature of mathematics itself and, pervasive beliefs about mathematics ability being fixed. This proposed PhD study intends to determine why grade three children aged eight years are experiencing mathematical resilience deficits in Kenya.

**Keywords: Resilience; mathematics anxiety; growth mindset; attainment; methodology**

## Introduction

Building mathematical resilience is about teaching children in such a way that will empower them to persevere with studying mathematics even in the face of adverse mathematical experiences. When children are made to believe that mathematics ability can be developed as opposed to being a quality that is fixed, they tend to demonstrate higher mathematics attainment (Dweck, 2017). Therefore, building children’s mathematical ability may aid their growth mindset and belief in their mathematical self-ability in the face of adverse mathematics experience. This study seeks to explore the persistent mathematics under achievement as revealed by Uwezo Kenya (2015) and the Kenya National Examinations Council (2019) grade three mathematics curriculum survey reports. Children who are mathematically resilient are more likely to be in a position to persist in learning mathematics (Johnston-Wilder & Lee, 2013; 2017). In this sense therefore, building mathematical resilience became an antidote for fighting mathematics anxiety in the classroom. Evidence shows that it is possible for teachers and parents to coach children to move away from a fixed mindset of “can’t do” mathematical avoidance towards a “can do” mathematical resilience stance (Johnston-Wilder & Lee, 2017; 2019).

## Building mathematical resilience

Mathematical resilience is defined as a positive stance to mathematics that allows children to function optimally in a mathematics lesson (Johnston-Wilder & Lee, 2013; Yeager & Dweck, 2012). Children experiencing mathematics anxiety require mathematical resilience to aid optimal functioning in mathematics lessons (Yeager & Dweck, 2012; Kooken, Welsh, McCoach, Johnston-Wilder, & Lee, 2013).

Mathematics anxiety research focuses on maladaptive responses to learning mathematics (Charmberlin, 2010; Hembree,1990). Against this background this study contends that the mathematical resilience children require to aid mathematics learning is a consequence of various attributes including classroom mathematics instructional strategy (Ofsted, 2008), the nature of mathematics itself (Jaworski, 2010), and pervasive beliefs about mathematical ability being fixed (Dweck,2017). This study intends to determine why grade three children are experiencing mathematical resilience deficits in Kenya. Studies in Kenya have shown that consistently from 2012 to 2015 about 61% of grade three children cannot compute grade two mathematics (Uwezo Kenya, 2015) and almost half of grade three children are learning mathematics below the official curricular requirement (KNEC, 2019; Njaru, 2016). This study intends to determine if this low attainment is due to mathematics anxiety and lack of a positive adaptive stance to mathematics. Evidence shows that mathematical resilience can be built (Johnston-Wilder, Lee, Brindley & Garton, 2015) when a schools' ethos encourages children to see that learning mathematics takes effort and that effort will result in improvement of their mathematics attainments.

Children with good mathematics resilience have growth beliefs related to their mathematical self-efficacy (Goodall & Wilder, 2015; Claro, Paunesku, & Dweck, 2016). Yeager and Dweck (2012) argued that children can be directed by teachers to see capabilities that can be built in them with effort and struggle. After a data analysis in my M.Ed thesis, two findings stood out: first, that many children struggle with learning mathematics and; second, that teachers lack capability to intervene (Njaru,2016). It is against this background that this study attempts to answer the following research questions: (i) How can teachers and parents' aid building grade three children's mathematical resilience in Kenya? (ii) Are there any strategies that can be put in place to aid the building of grade three children's mathematical resilience in Kenya? (iii) Is there a statistically significant difference in mathematics attainment of grade three children supported in building mathematical resilience from the mathematics attainment of grade three children not supported in building mathematical resilience in Kenya?

## Theoretical framework of the study

This proposed PhD study will be guided by Johnston-Wilder & Lee's (2010) theory of building mathematical resilience to interrupt the children's potentially negative adverse mathematics experience. From the perspective of this theory, mathematical resilience is a multidimensional construct that aids optimal mathematics functioning in children with mathematics anxiety. It involves a dynamic process that promotes a positive adaptive stance to children studying mathematics despite adverse mathematics experiences (Johnston-Wilder & Lee, 2010; 2013; 2015). Unfortunately mathematical resilience happens by accident in the classroom if at all (Johnston-Wilder & Lee, 2010; 2013; 2015). Fortunately, Johnston-Wilder & Lee's (2010) theory suggests four protective attributes that may help to interrupt the effect of adverse mathematics experience and aid children studying mathematics to persist through challenges presented by studying mathematics. Based upon Johnston-Wilder & Lee's (2010) theory of mathematical resilience this proposed PhD study will hypothesise that the mathematical resilience grade three children with mathematical resilience deficits require is a multidimensional with four correlated protective affective attributes.

The first attribute is value: teachers and parents have a duty to coach children to know the value of mathematics in their life and to enable them to internalise that they are valued members in a mathematics classroom. According to the expectancy-value theory children will be motivated to persist in studying mathematics if they are coaxed to perceive mathematics as valuable and when enabled to internalise that they are valued members of mathematics community (Chouinard & Roy, 2007). In this sense therefore value of mathematics will be determined by the children's perception that studying mathematics is valuable to them. Evidence shows that the more the children are coached to perceive mathematics as valuable and to internalise that they are valued members of the mathematics classroom the greater is their motivation to persist in learning mathematics (Johnston-Wilder & Lee, 2010; 2013; 2015; 2017; Johnston-Wilder & Moreton, 2018). In the same vein evidence shows that once the children know they are valued in a mathematics lesson they become more able to undertake mathematics challenges in the classroom (Cousins, Brindley, Baker, & Johnston-Wilder, 2019; Johnston-Wilder, & Moreton, 2018). In this sense therefore, it is important for teachers and parents to remove classroom mathematics learning barriers to enable children in a mathematics lesson to internalize that mathematics is valuable and they are also valuable in mathematics by according them unconditional attentions.

The second attribute is struggle: struggle is based upon Bandura's (1989) theory of personal agency as "ability to control one's interpersonal intelligence" (p.175) and a confession that struggle in mathematics is universal even to children gifted in mathematics (Bandura, 2000). Children with this attribute are aware that struggle with mathematics is a common thing to every children learning mathematics. In this sense therefore, children need to be coached to develop personal agency in learning mathematics. Building children's personal agency aids them to persist in learning mathematics even in when facing mathematical obstacles (Bandura, 2000; Mason, Briton, & Stacey, 2010). Children who are enabled to believe that struggle in mathematics is universal to all children will have tolerance and stronger staying power in studying mathematics. These children develop a growth mindset about mathematics (Johnston-Wilder et al., 2016). Therefore, it is important for teachers and parents to coach children in a way that may enable them to develop mathematical personal agency allowing them to overcome their passivity in the face of adverse mathematical experience (Maier & Seligman, 2010).

The third attribute is growth: this is a belief that mathematics knowledge is not limited and that mathematical growth is possible (Dweck, 2017; Johnston-Wilder, et al., 2016). According to Dweck's (2000) growth mindset theory of learning mathematics, children who attribute their success to interpersonal intelligence have a mastery of goal orientations in which they seek challenges and develop strategies in response to mathematical difficulties. In contrast, having a fixed mindset theory of intelligence orients children to a concern over mathematics attainment and mathematics avoidance that would result in mathematics difficulties and mathematical avoidance behaviour. Children who have a growth mindset rather than a fixed mindset about learning mathematics are able to overcome mathematics learning barriers in a mathematics classroom (Dweck, 2017). The construct of mathematical resilience developed from Vygotsky's (1978) zone of proximal development into a consideration of the protective affective attribute growth zone model that aids the development of the growth mindset in a mathematics lesson (Johnston-Wilder, 2013; Johnston-Wilder et al., 2016). Optimal mathematics functioning happens within the growth zone. However, for mathematics learning to take place teachers and parents must make a deliberate effort to ensure that growth zone (mathematics classroom) is mathematically secure, consistent and predictable. Also, it should allow children to get mathematically stuck, make mathematical mistakes, get mathematics support, know where to enlist the support, and find mathematics challenges in the classroom (Johnston-Wilder, 2013; Johnston Wilder et al, 2016). Children with mathematics resilience are said to possess a growth mindset belief related to their positive mathematical ability (Claro, Paunesku & Dweck, 2016). They perceive mathematics as activities for all not for a few elite peers in the classroom.

The fourth attribute is resilience in mathematics learning (Dweck, 2017; Johnston-Wilder & Lee, 2013; 2017; Johnston-Wilder & Moreton, 2018) which is a mathematics orientation geared towards aiding children to experience a positive adaptive stance to mathematics. They are coached to be aware that ( i) mathematics is a valuable subject (ii) mathematics learning involves struggle (iii) mathematics learning involves getting stuck and making mathematics mistakes in the classroom (Johnston-Wilder, & Lee, 2013; Peatfield, 2015). However, evidence shows that lack of these attributes inhibits optimal mathematical functioning in the classroom (Lee & Johnston-Wilder, 2017), thus isolating children from learning mathematics (Lee, Johnston-Wilder, Pardoe, Richards, Baker, Heshimati, & Nyama, 2018). Teachers and parents who lack these attributes may have a notion that children with mathematics anxiety have low mathematics ability and therefore can only do well in other subjects of the curriculum (Rattan, Good & Dweck, 2012). This ill-thought may inhibit the building of mathematical resilience to these children because teachers and parents are more likely to tell them that they are just not mathematical children and most likely assign them less mathematics attention. Further, Rattan et al.’s (2012) study found that confronting children for having a deficit in mathematical resilience leads to the lowering of their mathematics attainment and expectations. Of importance, Rattan et al. (2012) advised that the effective way to build mathematical resilience when children do not perform well in mathematics is to coach them to know that learning mathematics requires struggle as in Mueller & Dweck’s (1998) advice that foci on optimal mathematics functioning rather than on logical-mathematical proficiency may put children’s mindset on a growth path which may aid them to challenge their negative mathematical self-efficacy in a mathematics lesson, an idea echoed by Johnston-Wilder, Lee, Garton, ,Goodall & Brindley (2013). However, children in a mathematics classroom may give up learning mathematics for lack of mathematical resilience (Lee, & Johnston-Wilder, 2017) resulting in a fixed mindset of “Can’t do” mathematics avoidance behaviour. However, evidence shows that teachers and significance others can intentionally make children mathematical children in a mathematics classroom (Cousins et al., 2019).

## Research Methodology

This proposed PhD study will employ a qualitative and quantitative research design using: (i) a semi-structured, guided set of interviews with teachers, children and parents, (ii) classroom observations and informal conversations with teachers, children and parents, (iii) a pre-test and post-test mathematics test from grade three children. The intention of the study will be to open up us much as possible the views expressed by the teachers, children, and parents. In so doing, this qualitative and quantitative research design will ensure that instruments used to collect data will pave the way for the one on one interaction with teachers, children and parents.

## Data Analysis Techniques

The qualitative data obtained from the semi-structured guided set of research interview questions, classroom observations and informal conversations will be analysed using themes. These themes will be quantified and analysed using a descriptive statistics approach and presented using pie charts, bar graphs and frequency distributions tables. Quantitative data obtained from grade three achievement tests will be analysed using quantitative statistics and presented using means, percentages, and standard deviation. Validity will be ensured through inter-rater validity verifications while the instrument's internal consistency will be ensured through a Cronbach's alpha coefficient test. The alpha coefficient level of less than 0.5 will not be accepted for this study.

## References

Bandura, A. (2000). Exercise of human agency through collective efficacy. *Current Direction in Psychological Science*, 9 (3), 75-78.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist,* 44 (9), 1175-1184.

Chamberlin, S., A. (2010). A review of instrument created to assess affect in mathematics. *Journal of Mathematics Education*, 31 (1), 167-182.

Chouinard, R., & Roy, N. (2007). Relationship among competence, beliefs utility, value achievement goals and effort in mathematics. *British Journal of Educational Psychology*, 77, 501-517.

Cousins,S., Brindley,J., Baker,J., & Johnston-Wilder, S. (2019). Stories of mathematics resilience. How some adult learners overcome affective barriers? *Widening participation and life long learning*,21(1),46-70.

Dweck, C. (2017). *Mindset* (2nd ed.). New York: Brown Little Book group.

Dweck, C. (2000). *Self theories: Their roles, motivation, personality and development.* Lillinton NC: Psychology press Taylor & Francis.

Jarworski, B. (2010). Mathematics Joy and rigour. In Johnston-Wilder, S., and Lee, C. (Eds.). *Learning practice and managing change in mathematics department* St.Albans: Tarqui Puplications. (15-32).

Johnston-Wilder, S., Pardoe, S., Almehrz, H., Evans, B., Marsh, J., & Richards, S. (2016). *Developing teaching for mathematics resilience for further education* 9th International Conference of Education. Research and Innovations ICERI 2016. Servile (Spain), 4-16 November,2016.

Johnston-Wilder, S., Lee, C., Brindley, J., & Garton, E. (2015). Developing mathematical resilience in school students who have experienced repeated failure. ICER2015, 8th International Conference of Education, Research and Innovation, ICERI2015, Seville (Spain), 16th - 18th of November, 2015.

Johnston-Wilder, S., & Lee, C. (2019). *How can we address mathematics anxiety more effectively as a community?* In15th International conference of mathematics education for the future project theory and practices.

Johnston-Wilder, S., & Lee, C. (2013). Measuring mathematical construct in application of the construct of resilience to the study of mathematics. In AERA 2013. San Francisco California, 27 May April-1 2013. Retrieved from http://Wrapwarwick.ac.ku 51559.

Johnston-Wilder, S., & Lee, C. (2010). Developing mathematical resilience: BERA conference paper, University of Warwick

Johnston-Wilder-, S., & Moreton, J. (2018). Developing mathematical resilience promoting practices in teacher. In ICERI 2018 *proceeding* (8228-8237). Servile Spain.

Kenya National Examinations Council (KNEC). (2019). *The 2019 report on grade three children curriculum Survey in literacy and numeracy achievement*. Government press: Nairobi, Kenya.

Kooken,J., Welsh, M., E., McCoach, D., B., Johnston-Wilder, S., & Lee, C. (2013). Measuring mathematical resilience: Application of the construct of resilience to the study of mathematics. In American Educational Research Association (AERA). 2013 Annual Meeting Education and poverty: Theory research, policy and praxis 27 April-1 May 2013,San Francisco, CA, USA.

Lee, C., & Johnston-Wilder, S. (2017).The construct resilience. In xolotzin & Ulisher (Eds.). *Understanding Emotions in mathematical thinking and learning* (pp.269-291). Cambridge, MA: Elsevier Academic press.

Lee, C., Johnson-Wilder, S., Pardoe, S., Richards, S., Baker, J., Heshimati, H., & Nyama, J. (2018).*Mathematical resilience workshop proceedings* 9th British Congress of mathematics Education (Warwick) PP 76-9.

Lee, C., Johnson-Wilder, S. (2017).*The construct mathematical resilience*. In: U. Xolocotzin Eligio, (Ed.). London Academic Press

Lee, C., & Johnston-Wilder, S. (2013). "Learning mathematics-letting the pupils have their say*" Educational Studies in mathematics,*83(2), 163-180.

Maier, S., F., & Seligman, M., E.(2016). Learned helplessness at fifty: Insights from Neuroscience. *Psychological review,* 123-349.

Mason, J., Burton, L., & Stacey, K. (2010). *Thinking mathematically* (2nd Ed.). Harlow: Pearson education.

Mueller, C., M., & Dweck, C. (1998). Praise to intelligence can undermine children's motivation and performance. *Journal of Personality and social psychology,*75(1), 33-52.

Njaru, M., H.(2016)."*Teachers application of Individualized Educational Programme on low academic performing learners aged 6 to 8 years",* in Loitokitok,Sub-County, Kajiado County Kenya (Unpublished M.Ed thesis). Kenyatta University, Nairobi, Kenya.

Ofsted. (2008). *Mathematics: Understanding the score.* London, Ofsted.

Paunesku, D., & & Dweck, C. (2016). Growth Mindset tempers the effects of poverty on academic achievement. *National Academy of Sciences,*113(31),8664-8668.

Peatfield, N.(2015). Affective aspect of mathematical resilience. In Adams G. (Ed.). *Proceedings of the British Society for Research into learning Mathematics*, 35(2).

Rattan, A., Good, C., & Dweck, C. (2012).Its ok – Not everyone can be good at math". Instructors with an entity theory comfort and demotivated students. *Journal of Experimental Social Psychology,* 48, 131-737.

Yeager, D., S., & Dweck, C. (2012).Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist,*47, 304-314.

Uwezo Kenya (2015). *Are our children Learning?* The state of education in Kenya in 2015 and beyond. Nairobi. Twaweza East Africa.

Vygotsky, L. (1978). *Mind in society:* Cambridge MA: Harvard University Press.