DEVELOPING MATHEMATICAL-RESILIENCE-PROMOTING PRACTICES IN TEACHERS

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Abstract

The construct 'mathematical resilience' [1] was developed to describe a positive stance towards learning mathematics, that includes both persistence and perseverance [2], recruiting support when needed. Mathematical resilience can be engineered within both formal and informal learning environments by strategic, explicit focus on the culture of learning mathematics. A focus on 'mathematical resilience' enables learners to manage and protect themselves from unhelpful emotions, such as mathematics anxiety, that may arise when mathematics becomes difficult, as well as to recruit appropriate support. Mathematical resilience is not just something that learners do or do not have, it can be grown.

In a previous paper [3] we described working with Further Education (FE) teachers to engineer the growth of mathematical resilience in their practice. In this paper, we discuss the outcomes of a teacher Work Group focussed on building mathematical resilience (January to July 2018). Following previous work on growth mindsets with teachers local to Birmingham, UK, through their Maths Hub, work done locally with FE teachers [4,5], and the work of Clare Lee [6] with a southern UK Maths Hub, teachers were recruited to join a local Work Group called 'building mathematical resilience'. The Work Group was advertised as 'suitable for primary, secondary and FE colleagues at all stages of their professional education'. 16 teacher volunteers were chosen to take part on a first-come-first-served basis.

The Work Group focused on developing teachers' awareness of affective barriers to learning mathematics, such as mathematics anxiety and avoidance, and how to develop more resilience in learners working on mathematics. Key concepts included: the hand model of the brain [7] to understand the impact of anxiety on thinking, the growth zone model [8] as a means to help learners understand and articulate their feelings when learning mathematics, and to promote mathematical safe-guarding, and some mindfulness techniques to trigger the relaxation response [9] if a learner begins to experience anxiety. Teaching for resilience also involves teachers developing in learners: a growth mindset; willingness to struggle (persistence); knowledge of how to work at mathematics when stuck and how to recruit support (perseverance); understanding of the meaning, value, personal relevance and purpose of mathematics.

Based on Dylan Wiliam's components for effective teacher learning communities, in which all teachers embrace the idea of continuous improvement, the local Maths Hub adopts an approach in which teachers collaborate to change their practice with: Choice, Flexibility, Small steps, Accountability and Support. The Work Group was organised as four face-to-face sessions combined with membership of an online community and pre-reading. The four sessions were: an introductory day of input, group learning and action planning; two twilight sessions of feedback, new learning, and personal action planning; a feedback day, sharing evidence of impact, evaluation and reviewing, and of beginning preparation for a joint publication to share the work with other teachers. This structure enabled the session leader to optimise teacher self-efficacy by sharing mastery, vicarious experiences, verbal persuasion, encouragement and positive affect. In the paper, we discuss the outcomes.

Keywords: mathematics anxiety, learned helplessness, mathematical resilience, teacher learning communities, action research

1 INTRODUCTION

The popular Work Group under discussion in this paper was made up of sixteen teachers from across the first three phases of education in the UK (primary, secondary and further education). In their application to join the Work Group, each teacher demonstrated an interest in developing their teaching practice in line with methods that would nurture greater 'mathematical resilience' [1] within their students. To this end, each teacher wrote an action plan outlining the small steps they would take between the Work Group meetings. These actions were based on the strategies designed from the outcomes of

previous research into mathematics anxiety [10] and mathematical resilience. Teachers adapted the theory to fit the context within which they were working and their personal capacity for change. Thus, the Work Group participants engaged in a modified action research cycle, the outcomes of which are discussed below.

2 LITERATURE REVIEW OF THEORY

2.1 Teachers' professional learning

According to the 'Standard for teachers' professional development' [11], effective professional development for teachers consists of a partnership between senior leadership teams, teachers and providers of professional development know-how. The Standard goes on to say that for the partnership to be successful, professional development should focus on improving pupil outcomes, be supported by robust evidence and expertise, be collaborative and include expert challenge, and be sustained over time. Similarly, the Advisory Committee on Mathematics Education (ACME) [12] identified the need to offer teachers of mathematics sustained and personalised professional development facilitated through collaborative learning groups and focused on the mathematics-specific knowledge required to become a highly effective teacher of mathematics. Alongside the approaches already outlined, a recent report [13], reviewing literature which specifically included methodologies with a positive link between teacher professional development and student outcomes, concluded that effective professional development should include active learning strategies within the delivery and execution, the use of models or modelling, and time for feedback and reflection.

The latest PISA study [14] showed that the average mathematics score for England remained stable since 2006 and is at the OECD average. The gap between the highest and lowest achieving 10% of pupils was equivalent to approximately eight years of schooling and demonstrably higher than many countries with a comparable average score to England. It is well documented that young people with strong educational outcomes at the end of the secondary phase of education are more able to take their place in society and contribute to the economy. Therefore, in England and elsewhere, there is a real need to improve educational outcomes in mathematics especially for the currently lower attaining pupils.

Wiliam [15] discusses in detail the impact of teacher quality on pupil outcomes. He concludes that increasing the quality of the teaching force is the only way to improve educational outcomes. Improving teaching quality could be achieved by raising the entry requirements for those wanting to enter the profession or by identifying the least effective teachers and using measures to remove them from the classroom [15]. However, these measures are unlikely to have an impact on pupil outcomes for a considerable time. Therefore, Wiliam suggests that the best approach is to invest in those who are currently teaching and working in schools and colleges. The focus for his professional development of existing teachers is formative assessment, as he sees this as the best way to ensure increases in attainment. However, it is his method of scaling up professional development for teachers that is the focus of this review.

Teacher Learning Communities (TLC), advocated by Wiliam and Leahy [16], are a means of focusing teacher professional development on the 'content'—that is, what changes teachers should make to raise pupil attainment—before considering the 'process' by which teachers can be supported in making those changes. In the Work Group, the content was shared via expert input in the first meeting and during the 'new learning' section of the two twilight meetings. This include introducing the concept of mathematics anxiety and how to mitigate some of the disabling effects, together with a framework for teaching for mathematical resilience which advocated four elements that teachers should develop in their pupils: a growth mindset; willingness to struggle (persistence); knowledge of how to work at mathematics when stuck and how to recruit support (perseverance); understanding of the meaning, value, personal relevance and purpose of mathematics.

Wiliam and Leahy [16] identified five key components to the 'process' aspect: choice, flexibility, small steps, accountability and support. The element of choice allowed teachers to focus changes in their practice on either a weakness or a strength. However, any changes in practice were required to focus on an aspect of the 'teaching for mathematical resilience' framework identified above. This was to ensure that any changes were likely to be beneficial to pupils as they were based on evidence of what worked. The flexibility to adapt strategies, rather than just copy 'off the shelf' techniques, was also important. Teachers were able to consider the strategies discussed and adapt them to their pupils and their classroom. This had to be done in small steps so that any change to already ingrained practice could be embedded and sustained. The accountability component allowed teachers to demonstrate how the

changes they were making to their practice were having an impact on the outcomes of their pupils. To do this, all teachers in the Work Group wrote a short action plan, which described the context in which they were working, identified three case study pupils and outlined the actions/changes they intended to implement. Prior to each subsequent meeting, the teachers reviewed their actions. During the two twilight sessions, teachers shared their plans and reviewed in small groups, often exchanging ideas which were subsequently adapted in the action plan for the following period. During the final meeting, participants constructed a poster summarising the work completed and they responded to questions regarding their actions and outcomes. This was part of the support provided by peers, which helped to sustain commitment through the time of the Work Group. Other support was provided by the authors via a closed online community, where resources and additional reading were posted, and questions were answered. The use of the TLC model of professional learning strongly reflects the 'Standards for Teachers' Professional Development' [11] and ACME [12] advice outlined above.

2.2 The affective domain

In our view, learners need to develop mathematical resilience to safe-guard themselves against developing mathematics anxiety. Bandura [17] implicitly defines generic resilience as improving self-efficacy by learners exercising agency (choosing or changing the task), learning to manage intrusive thoughts and learning to manage emotional distress: '*a resilient sense of efficacy requires experience in overcoming obstacles through perseverant effort'* (p. 3). However, if learners are given challenging tasks to overcome in an environment with insufficient agency and without teacher awareness of emotions, the risk of developing mathematics anxiety is increased.

The growth zone model is a tool for enabling awareness of emotions to develop in the mathematics classroom with a shared language (Fig. 1), thus enabling leaners to develop mathematical resilience. The hand model of the brain is a tool to recognize when emotional distress is impacting upon learning, and the relaxation response [9] is one way to manage emotional distress. Thus, we sought to introduce the teachers to the growth zone model, the hand model of the brain and the relaxation response to support their learners in developing mathematical resilience.

Figure 1. The growth zone model.

According to Williams' model [2], resilience can be thought of as having 3 constituent parts: confidence, persistence and perseverance. Confidence is about perceiving success as permanent ("together we can always work it out") and pervasive ("I am smart enough; I have what it takes"); persistence is about perceiving failure as temporary ("when we cannot work it out, I can learn") and success as personal ("I keep trying"); perseverance is about perceiving failure as specific ("I can't do that problem yet") and external ("I was not good in maths because the teacher took steps that were too big for me").

Thus, we set out to help teachers increase learners' confidence, persistence and perseverance, supported by explicit awareness of the 'red zone'.

3 CONTEXT AND METHODOLOGY

In July 2014, the UK Coalition Government launched the Maths Hub programme by naming the 32 schools and academy trusts from across England who had successfully applied to become a Maths Hub 'lead' school. The core purpose of the Maths Hubs was to help schools and colleges across all phases (early years to post-16) lead improvement in mathematics education, with a specific initial focus on

implementing the Asian style 'mastery' approach [18]. National co-ordination of the Maths Hub programme was provided by the National Centre for Excellence in the Teaching of Mathematics (NCETM). All Maths Hubs were required to form, and recruit to, several Work Groups focused on specific national priorities. However, Hubs were also given autonomy to set up funded 'innovation' Work Groups, which focused on different aspects of current mathematics education practice. The Work Group under discussion in this paper (Building Mathematical Resilience) was one of those innovation Work Groups formed by the Central Maths Hub, based in Birmingham, UK, in response to the increasing local and national interest in the theory of 'growth mindset' [19]. The Work Group, which ran from January to July 2018, followed highly successful Work Groups focused on growth mindset in the previous two years. The format of the Work Group was therefore well established, as was the Work Group leader who provided consistent leadership across all three Work Groups.

To evaluate the effectiveness of the Work Group, data was collected from a variety of sources. Nationally, each innovation Work Group uses the Maths Hubs Work Group Self-Evaluation Tool Kit, which advocates evidence collection at stages throughout the life of the Work Group as well as follow up case study analysis of three participants some time after the end of the Work Group. In this Work Group, an adapted version of this toolkit was used. Participants were required to complete one final evaluation questionnaire, which the Work Group leader summarised in the final report [20] submitted to the NCETM. Twelve final evaluations were submitted. As participants were required to write, review and regularly submit to the Work Group leader, an action plan, data was also available in the form of reflective evaluations at stages through the Work Group. Sixteen action plans were available for scrutiny, some partially completed.

The final source of evaluative data was made available following face-to-face interviews with consenting participants during the final Work Group meeting. The interviews were semi-structured and undertaken by the authors of this paper together with a visiting PhD student. Interviews were recorded and then transcribed or notes were taken and then written up. Nine interviews were conducted and the details from nine transcribed interviews have been used, together with the data described above, to identify the five themes described below using a thematic analysis approach [21].

4 THEMES

From the data, 5 significant themes emerged.

4.1 Path-smoothing before the Work Group

In the first TLC meeting, the new learning section focused on what it means to struggle in mathematics and what teaching strategies may support pupils to persist when they get stuck [22]. Natasha, a Year 5/6 teacher, came to the realisation during the discussion that she tended to step in too soon when she noticed a pupil was stuck and, instead of allowing the pupil to struggle, she used questioning which eventually enabled the pupil to resolve the problem. This is something described by Wigley [23] as the 'path smoothing' model of teaching, in which teachers remove any potential barriers by breaking down the mathematical processes into small steps. Intended to be helpful, this can lead pupils to believe that they are not able to do mathematics. In her subsequent review of her action plan, Natasha described the enquiry she conducted, both via lesson observation and reading, which showed to her that teachers have a propensity to lead pupils towards a solution from the point of view of their own method of resolution and not that of the pupils. She concluded that this teaching strategy "*is ingrained in us as teachers and it is us who need to change in order for children to gain more resilience and allowing children more quality thinking time*." Natasha therefore focused her actions on developing her questioning skills so that she listened to pupils' responses and guided them based on what the pupils were thinking rather than how she was thinking. She also acknowledged that "*change needs to be done over a period of time*."

4.2 The model of the Work Group

In the final Work Group evaluation, most of the members of the Work Group noted the value they placed on working collaboratively with colleagues from other phases of education. For example, Simon, a secondary Head of Mathematics based at a large urban academy school, stated "*having the chance to speak to a wide variety of teachers from such diverse backgrounds has opened my eyes to the variety of ideas and techniques that teachers are using*". Also, Jenny, a Year 2 primary school teacher, stated that she "*found it really useful to work with others to gather ideas of things to try*". Indeed, following the second TLC, Jenny was encouraged to adjust her action plan after a discussion with another primary

school teacher: "*I am going to find time to take each of my target children individually and give them a problem-solving exercise… I want to elicit how they feel when they do the problem and introduce them to a simplified version of the growth zone model.*"

The collaboration described above was facilitated during the Work Group meetings through both formal and informal sessions. For example, in the first and last meetings, which were full day sessions, members of the group had the opportunity for informal discussions as well as conversations with the authors. During the two twilight meetings, the formal agenda (see [20]) ensured all members were able to feedback their actions and the impact of those actions on their case study pupils. The Work Group leader ensured that the feedback was shared in groups of four or less and that the groups were allocated rather than allowed to form spontaneously. This ensured that all participants had the opportunity to share with each other and share across phases. When sharing outcomes, participants experienced both personal and vicarious success which spurred them on to set up their actions for the following stage. The use of a 'teaching for mathematical resilience' framework ensured that the chosen actions were based on evidence of what worked; the sharing of strategies that participants already used in their practice, which fitted the framework, added credence to those strategies. For example, Imogen, a teacher based in a school for children and young people with a primary diagnosis of Autistic Spectrum Disorders (ASD), stated "…*the process of creating an action plan etc., reflecting/discussing what we had done*…" were aspects of the Work Group that made it effective for her.

Another effective aspect of the Work Group model was highlighted by Louise, a teacher working in a Further Education College, in her final evaluation. She stated, "…*it's been great to experience the Growth Zone Model as a student when participating in the Work Group and this has deepened my understanding and skill in adapting my teaching practice.*" During the two twilight sessions, participants were asked to work on two problems, with the Work Group leader modelling how to use a printed copy of the growth zone model (figure 1) to indicate where they would place themselves at the start and end of the problem-solving session. This chimes with Mason [24]: "…*the best way to sensitise yourself to learners' struggles is to experience parallel struggles yourself*."

4.3 Improved understanding and helpful language

Most of the teachers found that the growth zone model enabled them to develop both a better understanding of mathematics anxiety in students and a language that can be used to facilitate conversations about emotional barriers.

Natasha used a hard copy of the growth zone model and counters for the year 5 pupils to show what zone they were feeling. Of one child, she reported: "*a lot of the time it would be in red because initially it was like, I can't do this, and slowly just from the little steps we were doing, so it might be using the resources, explaining the vocabulary, not just to her but generally keep unpicking things, umm, offering strategies to support each other so how can we help each other? And talk about different scenarios not just maths and then slowly her counter slowly got into the yellow ... she will always now ask for the challenge whereas initially … it was always the red and I can't do it, I can't do it, I don't understand it, this is too much too hard."*

Louise reported: "*I have been able to more readily recognise when learners are moving in to danger zones and I am more relaxed and confident in facilitating the changes needed to move in to a safer zone."* At the end of the Work Group, Louise said her case study pupils "*had moved away from negative previous experiences of maths to a much more positive outlook of I can do, I want to do it, I can achieve. I like numbers and the challenge."*

Annette noticed that children in her year 4 class tended initially to miss out the growth zone and go straight to their red zone. These children became more aware of feelings and ready to be challenged. Imogen's pupils with ASD enjoyed talking about emotions, feeling it was good to share. Imogen's teaching assistants said it was useful having the individual GZM on the desks – it meant they didn't have to ask how the learner was feeling.

According to Simon, previously there was no vocabulary to describe what he was observing and resonance was experienced with things he had noticed previously. Other teachers became aware or more aware of mathematics anxiety and developed recognition that some observed behaviours may be rooted in anxiety or avoidance in defence of self. This extended to increased awareness of parent mathematics anxiety [Gareth] and anxiety impacting on performance of peers [Matthew].

As a teacher of very young children, Jenny was very wary of introducing the red zone; children in her year 2 enjoy mathematics, and she was mindful of creating negative feelings prematurely. However, as

children grow older, they are increasingly likely to encounter peers experiencing mathematics anxiety. Jenny decided to use a puppet to discuss with her children how does it feel to be in the red zone (angry), and that it is not ok to be in red zone for long. Jenny also commented*: "It has been fascinating to consider and hear from colleagues how a relatively simple model can be used as a powerful tool to help those with anxiety."*

4.4 Empowered change in students

Teachers reported significant changes in many of their students during the project. Sophie described noticing a student opening and closing her hands, sometimes one and sometimes both, whilst working on a challenge, using the brain hand model to help her through her anxieties when not able to solve a problem. Gareth reported that "*students are aware of signs, symptoms and their own feelings surrounding anxiety and potential methods of counteracting this."* Similarly, from the perspective of Louise: "*I could see two very different students at the end of the year; both had developed their confidence and perseverance and were less anxious when dealing with unfamiliar topics. We had moved away from negative previous experiences of maths to a much more positive outlook of 'I can do', 'I want to do it', 'I can achieve'. 'I like numbers and the challenge'.*"

Imogen reported boys' growth in confidence as boys became more prepared to talk. One of her cases, Peter, a year 10 boy, said it was good to talk - he said it helped him understand how he feels. "*Now he can get out mathematics equipment if he is stuck – he believes he has changed for the better*." Students became "*aware that others experience the same emotions as them. They are better able to identify and communicate their emotions. They have begun to develop a bank of strategies to use when faced with a challenging maths problem*."

Some learners explicitly changed their beliefs about their capabilities. For example, Louise reported an older learner saying: "*My maths teacher at school would embarrass students for making mistakes whilst telling some of us we weren't good at maths leading us to believe it. I don't believe it anymore."*

Noticeable changes happened to learners in the primary sector also. Annette said that "*Children are realising it is OK to find this [maths] challenging*." According to Jenny, "*children in my class are much more able to recognise the things they can do to help themselves. They often use the models and images they have been taught. I think I have successfully dispelled the myth that in order to be good at maths you need to be clever or a genius!"* One of Natasha's case study children said initially: *'I hate maths, I am in here because I am thick'* – "*she used the GZM to show anxiety which was shown through anger/frustration. De-escalation techniques were implemented. She now will be in the orange/green zone (occasionally red) and always wants to be challenged. She enjoys maths! And has resilience."*

Louise noticed learners making more use of temporary recording and using a wider variety of ways to get unstuck. As Natasha stood back from helping immediately, she noticed learners becoming more willing—even keen—to be challenged, asking for less teacher help and showing more persistence and perseverance.

Sophie gave an example of learners using more emotional coping strategies, such as changing their breathing, and saw learners becoming less resistance to learning mathematics. Gareth also noted that "*Disruptiveness, possibly masking fear/inability/ anxiousness has been reduced and students are more willing to open up and say what they are thinking.*" Many Further Education teachers find class behaviour difficult. Ray, who works with vocational students, observed: "*Whilst the group I teach aren't making significant progress in their assessments, there has been a distinct improvement in attendance and punctuality. Learners' attitudes to working in class have improved together with better classroom behaviour.*" Several other teachers reported improved behaviour and less resistance to mathematics; Ray reported: "*improvements were noticed in attendance, punctuality and overall behaviour in class"*. Lesley found that on average the class attitude to mathematics improved.

Gareth reported that the use of the Growth Zone Model caused anxieties to reduce. "*This is documented by the full engagement of students into solving linear simultaneous equations (year 10 set 3), including those that require multiplication and some rearrangement. This is a great achievement considering some student targets are only grade 3 by the end of year 11. This demonstrates that they are willing to have a go, a principle of the growth mindset theory. Students have also embraced the struggle of understanding the elimination of common terms and whether we have to add or subtract to achieve this. Work in books has shown if they are getting it wrong then they going back and trying again.*"

4.5 Changed practice

There was unanimous agreement from the participants that, due to being in the Work Group, their teaching practice had changed in some way. Several stated that they had explicitly used the growth zone model, the hand model of the brain and breathing techniques to encourage pupils both to understand and to control their emotions whilst engaging in mathematical tasks. For example, Annette, Simon and Imogen stated: "*I have explicitly talked about the GZM and feelings related to maths"; "I've considered the importance of making it explicit to students what difficulties they may come across and assuring them that it is OK to be in the growth zone where it may be a struggle" and "Greater emphasis on the emotions surrounding maths during lessons.*" A change in practice, noted by Gareth in his first action plan review, was in the way he gave his students more time to respond to his questions so that they did not become immediately anxious: "*I have also adapted my own personal approach by forewarning students that this might 'put them on the spot' and allowing more time to think through answers or coming back to them once they have had a period to think.*"

After discussing mathematics anxiety explicitly with students, some participants noticed less resistance and a greater willingness to struggle from their students; for example, Sophie said: "…*students were quite curious about the ideas and this helped them to become more at ease with their learning*…"; and Louise provided a quote from one of her case study students to exemplify the change: "*I believe "not knowing" is temporary and I think I can overcome this with personal effort*." In her interview, Annette reflected on the actions she had taken which contributed to her pupils' positive feelings about doing mathematics: "*… I think I have been quite …open and honest about …. how it's OK to struggle with things and how to... establish a classroom environment where the children know that it's OK to struggle. … And encouraging them to push themselves and try to get themselves into their stretch zone rather than sitting back in their comfort zone. So, I think probably that's the main area and establishing the classroom straightaway as a safe zone for them to be in as learners.*"

Working on ways to widen the variety of strategies students use when they are stuck, or to help develop their perseverance, has also caused participants to reconsider how they teach and work with their students. Matthew, who actually worked with three teachers in his Primary setting rather than directly with students, stated: "*It has caused me to reflect on how I lead and nurture teachers within my school. I now use different and more varied methods than I have previously*…". Jenny says: "…*I have also tried to reinforce as regularly as possible the strategies I have tried to promote: i.e. drawing pictures of problems, using working walls, asking a maths partner before me*." However, as Louise states, changing practice is not easy: "*It doesn't appear natural to stand back and not step in, but this has thwarted the development of those personal characteristics needed to become resilient…. Students need to decide when they need to gain support and have clear choices about what is available*."

5 DISCUSSION

One of the intended learning outcomes for this Work Group was focused on participants' professional learning: specifically, increasing their knowledge and understanding of the pragmatic construct of 'mathematical resilience'. Using both guidance about how to support pupils who are anxious when tackling mathematical problems (the hand model of the brain, the growth zone model and mindfulness techniques to trigger relaxation) and the framework for teaching for mathematical resilience, participants grew in confidence when both discussing the issues and implementing changes to their teaching practice. All participants were passionate that there was a need to focus on affective barriers to learning.

When discussing pupils' willingness to struggle through a mathematics problem, it became apparent that the main teaching strategy used by participants was that of 'path smoothing' [23]. This ensured that pupils stayed in their green (comfort) zone, became reliant on rules and procedures and became unwilling to approach unfamiliar problems and created learned helplessness. Participants found that not stepping in too soon to support pupils or students was a difficult change to make but worthwhile for their pupils and students in the longer term. The focus on developing perseverance and persistence in pupils enabled this mix of teachers to share strategies across phases and adapt the ideas they had not tried before to their age group and pupils. This focus enabled learners to increase the range of options they had when they got stuck. For example, Jenny states: "*Children in my class are much more able to recognise the things they can do to help themselves. They often use the models and images they have been taught"* and Imogen reports "*They [the pupils] have begun to develop a bank of strategies to use when faced with a challenging maths problem*."

As the Work Group participants spanned three phases of education, with ages from 6 to adult, discussions during the meetings highlighted a key question: when do students start to exhibit mathematics anxiety? Jenny was "*…very mindful of creating any negative feeling towards maths in my Year 2 classroom as my surveys have shown that they overwhelmingly have a very positive attitude towards maths and I am reluctant to do anything which might undermine this!"*. One of Louise's case study students (an adult) explained that her experience at primary school was good, and problems with mathematics came at secondary school where her teacher for five years provided no alternative methods (to solve problems) or support. An alternative view from Simon, in his interview, suggested that, from his perspective, some students were entering his secondary school with a fixed mindset towards mathematics having experienced mathematics as a subject that is 'right or wrong' at primary school and having developed mathematics anxiety. The dominant and passionate response to these discussions from the participants was that no student should be experiencing challenge in mathematics without safeguarding (i.e. the growth zone model, hand model of the brain and relaxation techniques).

Finally, some participants identified in-school barriers to developing the ideas of mathematical resilience more widely than their own classroom. Gareth, in his interview, described his worst experience on the Work Group as "…*trying to persuade my SLT to get on board with it*." His frustration was compounded by the fact that one of the whole school improvement targets was to develop learners' resilience and mindset. This situation, as well as all those described previously, clearly demonstrates a need to widen the scope of people's understanding of resilience to include academic resilience in general and mathematics resilience in practice.

6 CONCLUSIONS

According to Sophie, who works in Further Education, "[the workgroup] *has helped me to deepen my understanding of maths anxieties and triggers… helping me to focus on how to help students overcome these barriers. My action research allowed me to introduce the ideas behind the growth model zone, the brain hand model and breathing exercises. Mainly the course helped to reinforce my thoughts on what stops our students learning and I had never connected their anxieties with a need to safeguard our students, so they feel comfortable and relaxed within their maths environment.*"

Jenny who works with very young children, said: "*I have learned a lot more about issues which arise around anxiety in maths, particularly how this impacts on children as they continue their maths education. It has been fascinating to consider and hear from colleagues how a relatively simple model can be used as a powerful tool to help those with anxiety. I have been able to see links with other training I have had over the year – mindfulness and challenging behaviour.*"

The professional learning experienced in the Work Group was seen to be highly effective and enjoyable. The accountability aspect of the Work Group, including the action plans, came through as an important part of the efficacy of the model. It was noteworthy that many of the teachers found the growth zone model helpful in reflecting on their own experience of personal development in the Work Group.

ACKNOWLEDGEMENTS

Thank you to the leadership of the Central Maths Hub for supporting this innovation Work Group and to Janet Baker (PhD student at the University of Warwick) for helping with face to face interviews. Also, to the NCETM for providing the funding for the Work Group and the lead school for hosting the sessions.

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