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Using peer mentoring to reduce mathematical anxiety

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ABSTRACT

Research has shown mathematical anxiety impacts on mathematical confidence and attainment, leading to avoidance of mathematics and mathematical careers. This research investigated if an intervention with peer mentors could help reduce students' mathematical anxiety. It took place at a Secondary School (11–18 years) in the South West of England, which has been rated as 'Outstanding' by Ofsted. Five female students (aged 11–15 years) identified by their teachers as mathematically anxious were paired with peer mentors (female, aged 16–17 years) to receive four one-hour intervention sessions over six weeks. The purpose was for the mentors to provide encouragement and demonstrate skills to cope with being 'stuck', thus building the students' mathematical resilience and reducing their mathematical anxiety. The students' mathematical anxiety and attitudes were measured with a questionnaire before the intervention and again after all four sessions. The qualitative data collected from the questionnaires was reported alongside data provided by semi-structured interviews, which was coded and analysed for common themes. Three out of four participants reported reduced mathematical anxiety and all four students demonstrated a positive attitude to the intervention. However, the findings were inconsistent regarding improved mathematical resilience and its effect on reducing mathematical anxiety.

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Mathematical anxiety; resilience; peer mentoring

Introduction

A problem noted in the classroom from personal observation and research (e.g. Arem 1993; Johnston-Wilder and Lee 2010a; Maloney and Beilock 2012) is that some students become anxious at the mere mention of mathematics. It appears that once these students are required to work independently on mathematical questions, a barrier goes up and they get 'stuck'. This seems to cause panic and anxiety that may actually prevent them from being able to complete the work (Ashcraft and Krause 2007). As a teacher it can be highly frustrating to observe capable students underperforming as a result of anxiety provoked by mathematics.

Previous research (e.g. Ashcraft 2002; Hembree 1990) has suggested the potentially far-reaching effect of mathematical anxiety in hindering a student's ability to understand mathematics and their attitudes towards mathematics. Ashcraft and Kirk (2001) stated that it acts like a dual task function, interfering with working memory, therefore making it

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more difficult to complete tasks. If students can be taught to cope with this anxiety, it could have a positive effect on their attitudes and attainment in mathematics. I have observed that some students seek support when this barrier goes up and sometimes they are able to proceed after guidance and reassurance, suggesting that their delayed progress may not be entirely due to a lack of ability.

The significance of understanding mathematical anxiety lies in its potentially limiting effect on self-esteem and performance. Those who are mathematically anxious have been shown to avoid mathematics and adopt negative attitudes towards it (Ashcraft 2002), potentially restricting their ultimate mathematical progress and career choices. Paton (2012) proposed in *The Telegraph* that high levels of mathematical anxiety in the United Kingdom (UK) is why only 7% of students select to study Mathematics post aged 16 (when it is non-compulsory in the UK). Consequently, along with the current decline of students selecting Mathematics at University level (Paton 2012), the population prepared for careers involving mathematics is reduced. Recently, it was proposed by George Osbourne (Chancellor of the Exchequer) and reported by McCann (2016), that Mathematics should be compulsory to aged 18 in England. This would increase the number of students studying Mathematics beyond aged 16, but not necessarily beyond aged 18. In fact, enforcing extra years of mathematics study for those who are anxious may have an adverse effect, potentially diminishing the number selecting mathematical careers. This demonstrates the need to understand mathematical anxiety, so it can be avoided, or addressed, to lessen the potential negative impact on society as well as the individual.

Johnston-Wilder and Lee (2010a) suggested that the pairing of mathematically anxious students with a non-mathematical adult could help develop a student's mathematical resilience, which could reduce mathematical anxiety. The research study reported here took a similar approach and paired mathematically anxious students with older peer mentors. As with Johnston-Wilder and Lee (2010a)'s research, the mentors were non-mathematical (not currently studying Mathematics or Physics) to encourage the pairs to establish a dialogue (Skidmore 2000) to reach a shared understanding. This aimed to demonstrate to the students that their ability was greater than they perceived, thus building their self-efficacy (the belief in one's own ability, Taylor, Peplau, and Sears 2006) and mathematical resilience with the aim of reducing mathematical anxiety.

Literature review

Mathematical anxiety is 'a feeling of tension, apprehension, or fear that interferes with math performance' (Ashcraft 2002, 181) and an adverse emotional reaction to mathematics or the prospect of doing it (Maloney and Beilock 2012).

Ashcraft (2002) found mathematically anxious people exhibited more negative attitudes to mathematics. Maloney and Beilock (2012) state that exposure to negative mathematical attitudes increases mathematical anxiety, which impacts learning. Both assertions suggest a link between mathematical anxiety and attitudes. I have observed too often, negative attitudes to mathematics being reinforced by gender stereotypes, as well as students' belief that they do not need mathematics or their family is non-mathematical. As Chinn (2008) asserted it appears to be socially acceptable to be mathematically illiterate, a view also described by Paton (2013) in *The Telegraph* who described low mathematical ability as 'a badge of honour'. Datta and Scarfpin (1998 as cited in Chinn 2008) defined this as 'socio-cultural maths anxiety'. This anxiety arises from cultural beliefs such as 'only clever people can do mathematics', which can lead to maths phobia. Maloney and Beilock (2012) suggest that regulating exposure to negative attitudes to mathematics may increase mathematical success. This is supported by recent research by the OECD (Adams 2015) who found that despite girls having a more positive attitude to school, they lacked confidence in Mathematics. Additionally, they suggest girls' performance could be boosted nationally and internationally by improving mathematical attitudes and parental encouragement. This demonstrates the requirement for an intervention for the mathematically anxious and the need for societal attitudes to change. The latest TIMSS (Staufenberg 2016) suggests this needs to happen promptly as their research demonstrates the reopening of a gender gap identified from students aged 9–10 where boys outperform girls.

Research indicates that emotional responses can have a detrimental effect on mathematical performance regardless of mathematical ability. Ashcraft and Kirk (2001) found that those who are mathematically anxious experience emotional responses such as confusion and struggle to focus because they are thinking about their perceived lack of mathematical ability. It seems fair to assume that difficulty to focus will have a detrimental effect on mathematical performance. A common consequence of this emotional response is that the students end up 'stuck', but not sufficiently aware of it (Mason 1982). However, the correct response once aware is not to panic, but to 'accept it and enjoy it, for it is a great opportunity' (Mason 1982, 131). This illustrates the importance of a student's belief in their ability (regardless of their actual ability) and how it can render them unable to perform. This is known as self-efficacy, which refers to our perceptions of our ability to carry out a task, in this case mathematics (Jarvis 2005). My research aims to raise a student's awareness of when they are 'stuck' and knowing what to do to deal with it appropriately.

Jarvis (2005) suggested that the most effective strategy for developing a learner's self-efficacy is to build their study skills to minimise their experience of failure and maximise their experience of success. This is supported by Jansen et al. (2013) who showed children in the Netherlands attempted more problems and improved their performance if they were pre-set a higher success rate. This would suggest that an intervention to relieve mathematical anxiety should use a level of work to challenge (and build ability) but encourage success, therefore increasing their mathematical self-efficacy. Greater success may encourage students to work on mathematical problems rather than avoid them, regardless of ability.

Treating mathematical anxiety

Newstead (1998) stated that if mathematical anxiety is treated performance can improve; which assumes the two are related. Research (e.g. Hembree 1990; Lyons and Beilock 2012; Sheffield and Hunt 2006) supports behavioural interventions as an effective treatment for mathematical anxiety, as opposed to interventions focusing on mathematical ability. Lyons and Beilock (2012) suggested providing students with the skills to 'marshal' cognitive control resources could help reduce the impact panic can have on cognitive load. My research will continue this theme and focus on using an intervention to change behaviours.

Sheffield and Hunt (2006) suggested that effective interventions usually require multiple sessions. However, in their research they used just a one-hour behavioural intervention to desensitise students to mathematical anxiety. They claimed spending more time working through a problem was unlikely to relieve mathematical anxiety; instead interventions should attempt to alleviate the anxiety rather than focus on intellectual ability. They found that mathematical anxiety decreased and mathematical performance increased in the intervention group after one week, demonstrating that a short period of intervention can still be effective.

This could be a more practical solution for teachers, if as Sheffield and Hunt (2006) claim it requires little specialist training, allowing older peers to administer and support students. Nonetheless, short interventions should be viewed with some caution. Jarvis (2005) states that academic self-efficacy can change in response to one major success or failure. Therefore, a short intervention that the student does not consider a success may be counterproductive.

Mathematical resilience

Johnston-Wilder and Lee (2010a) suggested that increasing a learner's mathematical resilience can reduce mathematical anxiety. They define mathematically resilient students as those who expect to find mathematics challenging when they are required to use it in new situations, but they will have strategies to help them approach it, cope with it and overcome 'I can't' attitudes (Johnston-Wilder and Lee 2010b) that are often associated with being 'stuck'. Johnston-Wilder and Lee (2010b) claimed that mathematically resilient students know the value of asking questions and experimenting, and adopt a realistic approach to their strengths and weaknesses. These students will take responsibility for their own understanding and seek help from others only as a last resort. Mathematical resilience is about building confidence in understanding (Johnston-Wilder and Lee 2010b) and possessing a positive self-efficacy and attitude. Therefore, finding a way to increase a student's mathematical skill may be key to boosting their self-efficacy and eradicating mathematical anxiety.

Johnston-Wilder and Lee (2010a) conducted research to deliberately increase mathematical resilience by using an intervention with 'Maths Angels'. The 'Maths Angels' were non-mathematical adults from within the same UK school, who were paired with a mathematically anxious student and prepared to face their mathematical anxieties together. The 'Maths Angels' role was to encourage talk, collaboration, experimentation and exploration, in an effort to increase the students' (and adults') mathematical resilience.

Dialogue and peer mentoring

Communication of mathematical ideas is central to increasing resilience, thinking and learning (Johnston-Wilder and Lee 2010a). Ashcraft (2002) suggested that by articulating ideas this improves a student's confidence and competence, increasing their mathematical resilience and perhaps their attitude to mathematics. Howe (1992 as cited in Myhill, Jones, and Hopper 2006) claimed that talk allows us to formulate ideas and shape them into existence. Ideas can then be reformulated to clarify understanding and focus. Using peers and encouraging dialogue appear to be key components in reducing mathematical anxiety.

The use of non-mathematical adults in Johnston-Wilder and Lee's (2010a) research forced the pairs to collaborate to reach a shared understanding, as opposed to the adult teaching the student, thus engaging in dialogic talk. A dialogue (Skidmore 2000) allows both members to contribute and reach a shared understanding. Myhill, Jones, and Hopper (2006) stated that dialogic talk builds on prior knowledge; enabling the process of constructing knowledge together. However, this all depends on the quality of that dialogue, the skills of the teacher and the preparedness of the student to be able to engage in dialogue. The use of a dialogue prioritises 'process over outcome' (Myhill, Jones, and Hopper 2006, 25) as opposed to a discussion where one person gives their viewpoint, such as the teacher leading a child (Myhill, Jones, and Hopper 2006). This 'allows learners a greater control and responsibility for learning rather than relying on the teacher' (Carnell 2000, 48), demonstrating how a dialogue may encourage greater independence, another characteristic Johnston-Wilder and Lee (2010b) suggest defines mathematical resilience.

Topping and Ehly (1998) describe peer mentoring as an encouraging and supportive relationship with someone more experienced, here meaning coping skills, as opposed to mathematical ability. Like Johnston-Wilder and Lee's (2010a) 'Maths Angels', they characterise peer mentoring as joint problem-solving, where a dialogue means working together to reach a shared understanding, provides positive reinforcement and positive role modelling. Again, collaboration and language are identified as key features and therefore an intervention needs to allow or create opportunities for a dialogue, perhaps by using peers as mentors during the intervention.

Previous research summarised by Topping and Bamford (1998) shows that peer tutoring in mathematics has been shown to produce significant improvements in achievement, attitude and interaction. This may assist in supporting the development of mathematical resilience and the reduction of mathematical anxiety. My research used peer mentors who modelled coping behaviours and a positive response to challenge and mathematics as a subject. Topping and Bamford (1998) suggested that working with peers enables a lower threshold of self-disclosure, therefore implying it may be less anxiety provoking and encourage more talk. The peer mentors were non-mathematical (not currently studying Mathematics or Physics) to dissuade them trying to 'teach' the student and to encourage a dialogue, in order to build mathematical resilience and coping skills. Moreover, peer mentoring aimed at encouraging positive attitudes towards mathematics and the developing students' mathematical ability, with the aim of reducing mathematical anxiety and potentially relieving any barriers to performance.

Methodology and methods

This research study aimed to understand what caused mathematical anxiety in students and whether it could be alleviated with a peer mentoring intervention, using a case-study design. It investigated the following research questions:

RQ1 – Can mathematical anxiety be reduced by improving mathematical resilience?

RQ2 – What is the influence of peer mentoring sessions on a student's attitude towards Mathematics?

The research took place at a state-funded Secondary School (11–18 years) in the South West of England, where five female students (aged 11–15 years) were paired with peer mentors (female, aged 16–17 years) to receive four one-hour intervention sessions.

Research process and methods

Participants received an intervention aimed to help improve their mathematical resilience through collaborative work with a peer mentor. It took place over six weeks. During week one the mentors were briefed, initial questionnaires (Appendix 1) were completed and consent obtained. The intervention sessions took place over the following four weeks. During the final, sixth week the students completed a follow-up questionnaire, a pre-interview questionnaire (Appendix 2) and an interview. Prior to the intervention sessions the mentors received a one-hour briefing explaining the research, the support available and the expectations. The briefing emphasised modelling a positive attitude to getting stuck, using resources to help before seeking support and allowing the students to take their time.

During the intervention sessions, the mentors were given a Scheme of Work as guidance. Each of these had the same structure, but were individualised to meet the learner's needs (identified from their last school test and initial questionnaires). The briefing instructed the mentors to be flexible and use their judgement, so as not to provoke anxiety in the learner. The learners were also invited to bring topics to the sessions that were causing them concern.

Methods for data collection

The main data collection method employed in this study was semi-structured interviews with the students. Additional data was collected from questionnaires and feedback sheets that were used as supplementary data to the interviews, the methods are reported here in the order they were implemented.

Questionnaires

Questionnaires were given to the mathematically anxious students before and after the intervention. The purpose was to initially assess their attitudes towards mathematics, their mathematical anxiety and observe any change. The questionnaires were not completed anonymously, but it was emphasised that it would not affect the students' grades or reports. Confidentiality was assured. However, the students' responses could have been influenced by social desirability (the desire to demonstrate socially acceptable behaviours – Taylor, Peplau, and Sears 2006) or demand characteristics (bias created by the awareness of being studied – Taylor, Peplau, and Sears 2006).

The questionnaire had five sections. Sections 2 and 5 provided qualitative data and are the focus of this article (Appendix 1). These questions were based on previous research from a review of literature (specifically Johnston-Wilder and Lee 2010b; Mason 1982), regarding resilient beliefs or behaviours and students' responses to being 'stuck'. They were open-ended to allow the students to respond freely.

As the researcher developed the questions, there is no research to suggest the reliability or the concurrent validity of the questionnaire. However, the criterion was specifically developed to test the research questions, because there appeared to be no comparison in existence, therefore the face validity appeared competent. The questionnaire was sent to experts for validation and a pre-pilot was conducted with seven volunteers (three boys and four girls, aged 12–13 years) to ensure it could be completed without support. The follow-up questionnaire, administered after the intervention, differed from the initial questionnaire by excluding Sections 2 and 5 (the qualitative data).

Interviews

Semi-structured informal interviews were conducted with all the participants involved to address the research questions posed.

Development of the Interview: Each student completed a pre-interview questionnaire prior to their interview (Appendix 2), which allowed the students to respond honestly and the researcher to plan and focus the interview time. The interview questions (Appendices 3 and 4) were open-ended to allow the students to talk freely about their ideas, attitudes and experiences. Some were specific to see how the students felt and whether they displayed any anxiety, others were seeking out traits of mathematical resilience. Questions to elicit practical responses were included to establish any changes required if the research was repeated.

Description of the Interview: The interviews were semi-structured to answer specific points the researcher needed to know, but allow for interesting, unexpected, personally specific data to emerge and for the researcher to be able to pursue interesting leads (O'Leary 2009). The questions were open, not leading, to ensure the answers reflected the participant's actual thoughts. The interviewer was a member of school staff and the impact this could have had on their responses should be taken into consideration.

Interview Procedure: The interviews were conducted individually, as O'Leary (2009) stated this will give the researcher control and the student the ability to talk freely and honestly. They were undertaken during free time in a small private classroom, they lasted approximately 20 minutes. The interview was audio recorded, and written notes were taken to capture non-verbal data. The participants were reassured of strict confidentiality and that the audio recording would be deleted after coding. The written notes were collated with the audio recording and information from the Pre-Interview Questionnaire. This was then transcribed and coded thematically.

Feedback sheets

Mason (1982) stated that the only way to learn is from experience and therefore reflection is the most important activity. This concurs with Johnston-Wilder and Lee (2010b)'s description of a mathematically resilient student. Consequently, every session finished with the student briefly reflecting on what they had learnt during the session. The peer mentors then completed a feedback sheet, which enabled the researcher to assess and monitor student activity in each session. This ensured the plan for the following session was appropriate and allowed issues to be followed up.

Methods of analysis

The qualitative data were analysed using the phases of thematic analysis outlined by Braun and Clarke (2006). This was selected to allow both deductive and inductive reasoning during the coding process.

Themes were identified in a predominantly deductive way, aiming to provide detailed analysis of specific areas. Codes and themes were identified from the pilot and a review of previous literature, these were then related to analysing the research questions (for example, confidence, attitude, improved study skills, peer collaboration/talk). This approach could lead to less rich data overall (Braun and Clarke 2006), so an inductive approach was also used to allow themes to emerge from the data.

Initially, interview data for each student was transcribed from the audio recordings, and collated with their responses to the pre-interview questionnaire, which allowed the researcher to familiarise themselves with the data and ensure the data were completely

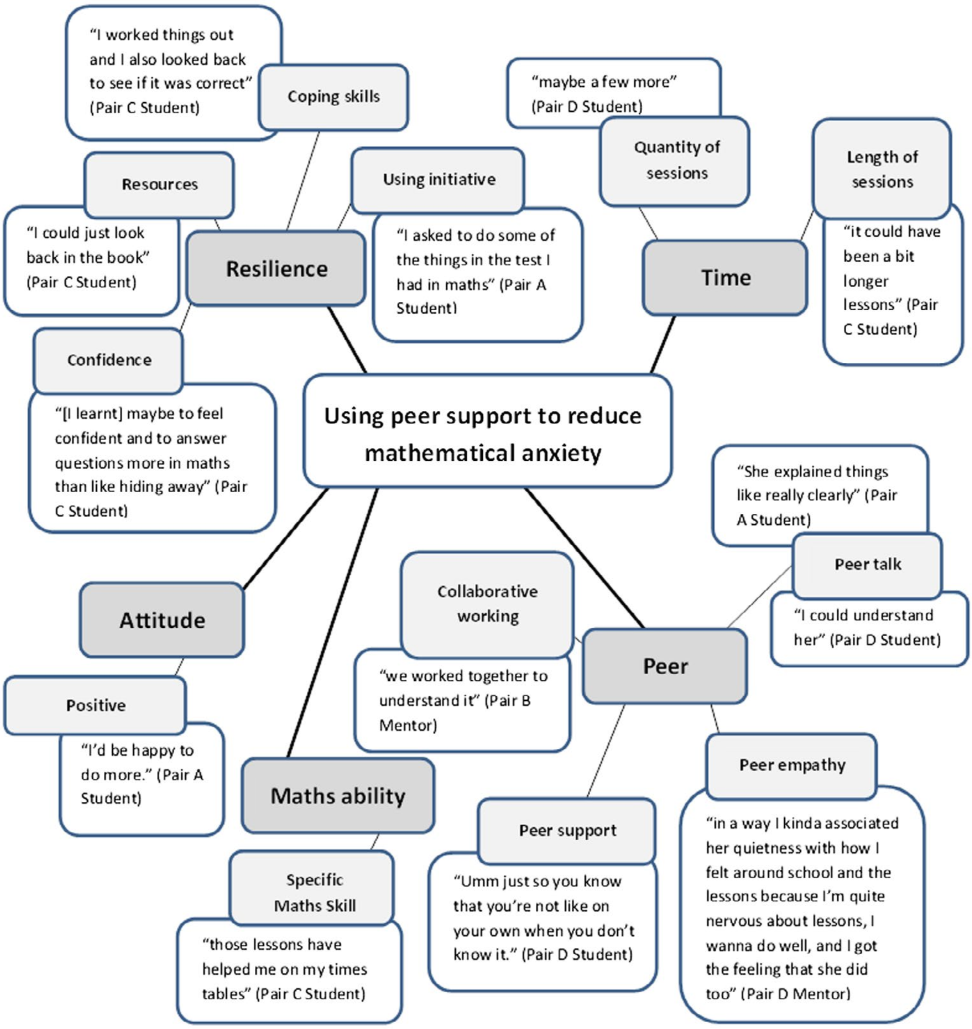

Figure 1. Thematic Map.

anonymised. After transcription, each interview was listened to again by the researcher (intra-data reliability) to ensure it was still representative. Next 'initial coding' enabled the researcher to pull out the essence of the responses. An initial list of codes was created and collated into sub-themes, such as 'peer talk' or 'collaborative learning'. This was reviewed to check it still represented the data and a thematic map (Figure 1) was drawn up.

Next the overarching themes (Meta-Themes) were selected carefully, ensuring they were representative of the data and not just paraphrasing the content, for example, the sub-themes; 'peer talk' and 'peer empathy' were placed in the Meta-Theme 'Peer'. At each level of analysis, the coding was compared with the transcribed data.

The data for each student was coded individually, in their pairs and in their roles as mentors and students, to consider if there were any themes specific to these groups. Finally, the data were considered as a whole to see the most common themes.

Sample and sampling

A purposive sample of five female students (aged 11–15 years), labelled A–E, was identified as exhibiting mathematically anxious traits by their teachers and the researcher. They were approached and given the option to participate. Data is reported on four of the pairings as student E only attended two sessions.

The Peer Mentors were a purposive sample of students (aged 16–17 years), who volunteered. Johnston-Wilder and Lee (2010a) used mathematically anxious 'Maths Angels', but found that many of them became too overwhelmed by their own anxiety during the study and had to withdraw because they could not support the students. Consequently, this research used non-mathematical (not studying Mathematics or Physics), but not necessarily mathematically anxious mentors to reduce this possibility but still encourage dialogue. However, potentially they were less able to identify with the students' anxious feelings. A pilot of the intervention was conducted using two female students (aged 13 years) paired with female mentors (aged 17 years). The timescale was the same to trial the methods and tools used. The mentors were paired with students selected by the researcher based on ability. Other teachers were consulted to avoid any obvious personality clashes and every effort was made not to cause additional anxiety or stress at this or any stage.

Ethics

The University of Exeter awarded Ethical approval for this research and additional consent was obtained from the schools Senior Leadership Team. Voluntary informed consent was gained from the younger students and their parents. The peer mentors gave their own voluntary informed consent and were briefed about confidentiality before the intervention took place. All participants were reminded of their right to withdraw at any time and that their responses to the questionnaires and interview would not affect any grade or school report. Other students were unaware of their participation, unless they chose to tell them.

Results

RQ1 – can mathematical anxiety be reduced by improving mathematical resilience?

The qualitative data presents evidence of subthemes demonstrating resilient traits from all the students. These were identified prior to and during the coding process, based on previous research (e.g. Johnston-Wilder and Lee 2010b) and themes that emerged from the data. These are evidenced and analysed below.

Peer collaboration

The data demonstrated that all pairs worked collaboratively during the sessions, which appeared to be more strongly demonstrated by the mentor than the student (e.g. 'we worked on it together', Mentor D, interview, 2014). Data from the feedback sheets completed by mentors provided evidence of the pairs empathising and identifying with each other. For instance, Mentor D noted that 'I kinda associated her quietness with how I felt around school' (Mentor D, interview, 2014). The students particularly commented on how they understood their mentor, and suggested that it was easier to communicate with the mentor than a teacher. For instance, both Student A ('She explained things like really clearly') and Student D 'Even when Miss explained percentages I didn't really fully understand it. It helped to have someone different explain it' commented positively in their interviews on the clarity of explanations provided by the mentors.

Use of resources

All pairs indicated on their feedback sheets that they used resources in their sessions, the most common being the Internet, textbooks and whiteboards. The mentors indicated 'the use of resources to make explanations easier' (Mentor C, questionnaire, 2014). Student D also explained in her interview that she had written down a mathematical vocabulary website they had found together and used it at home to support homework.

Coping strategies

Various strategies were mentioned by some of the students. Student A's responses to all the questions in Section 2 of the initial questionnaire included asking a teacher or a parent for help when 'stuck', which may suggest a lack of resilience prior to the intervention. The interview data after the intervention indicate an increased confidence in her own ability, which would be a sign of increased resilience ('It helped me understand everything', Student A, post interview, 2014).

Student B's responses to qualitative questions in the initial questionnaire indicated that the student tried to 'get around the problem' or 'work it out' before seeking help, therefore exhibiting resilient behaviours prior to the intervention. Consequently, post intervention data indicates no change in her resilience, but does demonstrate an improved confidence: 'Umm well I got loads better at division like I ended up doing it quite quick and right in one and I never could do that' (Student B, interview, 2014).

Confidence

Pair B appeared to work on specific resilient behaviours such as confidence that neither questionnaire picked up. The interview data, specifically from the mentors, indicated that the intervention had a positive effect on the student's confidence. For instance, Mentor A commented in her interview that 'over the time of doing them she began to be more confident in herself and like in her ability'.

Student C described in her interview that she learnt 'to feel confident and to answer questions more in maths than like hiding away'. She also demonstrated other resilient traits, such as using resources and checking mistakes.

Student D's response to qualitative questions on the initial questionnaire suggests a lack of independent working (uncharacteristic of resilience) because all the responses indicated asking for help when 'stuck'. During the interview, both the responses of Student D and Mentor D indicated some collaborative working, but at times it reflected a teacher–student relationship 'I kind of took control of where it would go because otherwise I would feel like she wouldn't know what to do' (Mentor D, interview, 2014). This illustrates the student's lack of independence, when working with her mentor, making it difficult to say whether any change in coping skills or resilience affected her mathematical anxiety. Perhaps the lack of change in resilience prevented a decrease in mathematical anxiety.

Mentor anxiety

In many of the mentors' interviews they discussed their own mathematical anxiety, through their uncertainty of their mathematical ability. Mentor B commented in her interview 'I'm glad I had a year 7. If they were any older, I would have felt, I probably would have felt a bit intimidated to be honest just thinking they're probably better at maths than me'. However, this was somewhat to be expected because the participants were 'non-mathematical' and previous research (Johnston-Wilder and Lee 2010a) suggested this would actually enable the younger students to identify more with their mentor, ensuring the pairs worked collaboratively. The students did appear to recognise this anxiety and saw it as a positive that they could identify with, because the mentors were 'really honest … and umm with like teachers you don't really get that because they wouldn't say that they didn't know' (Student D, interview, 2014).

The findings suggest that mathematical anxiety improved after the intervention, for all students except Student D. There is no clear explanation for their increase in anxiety. This could be an anomaly or that the student was having a bad day. It should not be discounted that the intervention provoked anxiety in the student; however, this was not demonstrated in the interview responses. Alternatively, the intervention may have increased the student's awareness of their anxiety, or they may have used anxiety positively as a challenge rather than as a barrier.

RQ2 – what is the influence of peer mentoring sessions on a student's attitude towards mathematics?

Attitudes towards mathematics

Attitude was not as prominent in the qualitative data as expected. This may be because generally all the students exhibited a positive attitude before and after the research study. This could be because they were the ones who chose to take part and those with negative attitudes to mathematics may have avoided the opportunity, as suggested by Ashcraft and Krause (2007).

All students indicated they would partake in the intervention again ('I'd be happy to do more', Student A, interview, 2014) knowing what it entailed and a common theme emerging from the interview data was the desire for more sessions. This would suggest a positive attitude towards the intervention, but not necessarily indicate a positive attitude to mathematics or their ability.

Summary

The findings demonstrate the positive influence of using peer mentors to help students with mathematics anxiety, whether it is offering support, talk or collaboration. There is evidence of mathematically resilient characteristics amongst the students and some can be linked to the peer support.

Discussion and implications

RQ1 – can mathematical anxiety be reduced by improving mathematical resilience?

The findings provided no consistency in the idea that improved resilience will decrease mathematical anxiety as the data is conflicting. Student A and C both demonstrated traits such as coping skills and the use of resources in the qualitative data suggesting some improved resilience, as well as evidence of decreased anxiety. This supports Johnston-Wilder and Lee's (2010a) idea that increasing mathematical resilience may help to reduce mathematical anxiety. It should be acknowledged that resilience and anxiety may be increased or reduced by other factors.

RQ2 – what is the influence of peer mentoring sessions on a student's attitude towards mathematics?

The interview responses suggested that the students' attitudes after the intervention were positive, with all students saying they would opt to take part again. However, further research could aim to distinguish between their attitude towards the intervention and their attitude towards mathematics and their ability.

Key themes

Meta-Theme – peer

The student responses to their peer mentors and vice versa were very positive, with both saying that they could relate better to each other because they were a peer. Strong themes in the interviews included how the student could talk, support, collaborate and empathise with their peer. This was good because the student felt more comfortable, and hopefully less anxious, it would have encouraged talk throughout the sessions. However, it is difficult to measure how much talk occurred, what form it took and how constructive it was.

The students' positive responses to peer collaboration supports Topping and Ehly's (1998) assertion that there is a stronger identification between peers, as the teacher is too distant and too competent to model. Peers can model enthusiasm and cooperation. This demonstrates what a valuable source of support a peer mentor could be, because they can encourage and relate to a student in a way difficult for a teacher.

Meta-Theme – time

A recurring theme throughout the interviews was the amount of time the students had for the intervention. Some suggested the sessions were too short, but the majority suggested they would like more sessions. Themes from the data suggested that the students felt they could identify with their mentor and therefore may have wished for more sessions because they enjoyed having their support or empathy. Núñez-Peña, Guilera, and Suárez-Pellicioni (2014) claim that interventions to alleviate mathematical anxiety need to be short and precise; suggesting that the length was not the problem. This is supported by Student B, who predominantly elected to work on her division and her feedback was that it was an adequate length to target a weak area. Student C also commented that it helped target her times tables.

Even if the length of time was adequate, there could also have been a number of other variables that may have had a positive or negative effect on a student's mathematical abilities, attitudes or anxieties during this time, for example, achieving a recent good or bad grade or missing lessons. Nonetheless this does not mean that the time was necessarily too short to have had any effects. Learning one new coping or mathematical skill is more than they may have learnt without the intervention.

Meta-Theme – Maths ability

Compared to the students, the mentors' data indicated a greater emphasis on introducing coping skills; 'it was helpful for me to give her some tips about how I have worked' (Mentor D, interview, 2014). The students' presented more emphasis on their mathematical ability and they appeared to define their success by the acquisition of new mathematical skills.

This maybe because they have not recognised the non-mathematical skills that they observed or acquired during the intervention or they have not conveyed this information to the researcher. They could have assumed that because they learnt the skills within a 'Maths Intervention' that they were specifically mathematical skills. This is similar to Arem's (1993) assertion that although anxiety may appear in mathematics, it may be situational and not be specific to mathematics. Perhaps more specific questioning in the interview is required to find out and to encourage the students to think more deeply about the skills they have acquired.

Interestingly the students present evidence of the mentors 'teaching' them, which is contrary to the mentors' feedback. Is this the student's perception of their mentors help? Alternatively, are the mentors reporting a different view of events because they are aware of the researcher's aims explained in the briefing? Could they be conforming to the demand characteristics of the study because they want to help or to be seen as doing what they were requested to do (social desirability)? It is challenging to find out exactly what happened during each session, especially how much of the talk was discussion or whether a dialogue was established (Skidmore 2000). The method could be amended so they were observed or recorded, but this could potentially be anxiety provoking.

Participant selection: perceptions of anxiety

One question regarding the method is the incompatibility of the teacher's perceptions of the student's mathematical anxiety and the student view. Student A was selected by their mathematics teacher as mathematically anxious but their responses to the initial questionnaire did not support this view. Reasons for this could be that the teacher's interpretation of mathematical anxiety differs compared to the researchers; or alternatively the student displayed test or general anxiety, as opposed to specific mathematical anxiety. Future research may include a different method for selecting mathematical anxious students, for example, screening the students with a more comprehensive questionnaire that controlled for test anxiety.

Limitations of the research

How do we know any changes in the students' attitudes or anxiety were related to the intervention? There are many possible events and extraneous variables that may have impacted on a student's responses. If as Jarvis (2005) states, one major success or failure can have a substantial effect on a student's academic self-efficacy: one good or bad lesson prior to completing either of the questionnaires may have had a reasonable effect on their responses. This could be assessed by using an additional questionnaire to elicit their responses again after a week to test reliability.

Another limitation of the methodology is the sample. Although not deliberate all participants were female. The teachers did identify fewer male students as being mathematically anxious and one was approached by the researcher, but felt he did not need the intervention. The sample was small, meaning no generalisations from the data could be made.

Research tools

The interview presented a challenge with the younger students who were quite nervous during the interviews appearing reluctant to make 'negative' comments. Their answers were shorter than the other students and provided less data. Perhaps this could be relieved by using a focus group in future.

This concurs with the mentors who said that the students were nervous or shy on the first session, but it seemed to reduce over time as they became more familiar with the process and their mentor. Additionally, some mentors appeared more anxious than others and if this research was repeated, it might prove useful to test the mentors' anxiety levels. This could indicate if the mentors benefited from the intervention.

Implications for practice and research

Strong conclusions cannot be drawn from this data as the sample is small and the findings are inconsistent. There is evidence of reduced mathematical anxiety after the peer intervention for some of the participants, although the cause is unclear. To gain a greater understanding of reducing mathematical anxiety and increasing mathematical resilience, future research would need to consider the tools used for identifying mathematically anxious students. Furthermore, it could use a wider sample to provide greater understanding of the causes and effects of mathematical anxiety and how to reduce them. Students with truly negative attitudes to mathematics are unlikely to take part; therefore, it might be useful to consider how to reach these students within a lesson environment. This research has demonstrated how positively the use of peer support was received, so one way to do this might be to invite older students into lessons with younger students, to model and support the students whilst they work.

To consider the long-term development, reduction and effects of mathematical anxiety and resilience, longitudinal research, as suggested by Devine et al. (2012) could be conducted over a school year or throughout a student's school career although practicalities, such as timetabling, and finding willing, reliable mentors, will need to be taken into consideration.

In the future, I wish to encourage more of these skills in a whole-class or perhaps ambitiously on a whole-school basis. Johnston-Wilder and Lee (2010a) stated that the ethos of the school is important in encouraging mathematical resilience. In my department we already encourage positive attitudes to mathematics, but perhaps this needs to be championed by colleagues in all subjects, particularly those with non-mathematical backgrounds, to embrace and model a positive attitude towards mathematics. Through this research I have found myself promoting more independent thinking and resourcefulness in lessons, quite often by encouraging and modelling a variation of Mason's (1982) three questions (What do you know? What do you need to know? How are you going to find out?). My aim is to enable students to approach problems positively and manage being 'stuck' independently. Where suitable I have continued to encourage the positive use of peer mentors, which has coincided with the increased use of older students in mathematics lessons as mentors.

Disclosure statement

No potential conflict of interest was reported by the author.

Notes on contributor

Imogen Cropp is a teacher of secondary mathematics with experience and interest in mathematics interventions. This research took place as part of her studies for her Masters of Education at the University of Exeter.

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Appendix 1. Initial questionnaire

Thinking about our learning in Maths

Please read each question carefully and answer as honestly as you can, there are no right or wrong answers. Your responses will be kept confidentially and not influence any assessment or report.

Please circle - **Gender:** Male Female

Year group: Year 7 Year 8 Year 9 Year 10

Section 1 - Please tick one answer for each statement.

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
I like Maths.					
I am good at Maths.					
Getting 'stuck' in Maths is a good thing.					
When I am set work in Maths I am usually sure I will be able to do it.					
I do not like Maths.					
When I am set work in Maths I am usually sure I will not be able to do it.					
If I try hard I can get better at Maths.					
In Maths lessons, I often need support from a teacher/teaching assistant.					
I can work independently in Maths.					
I am not good at Maths.					
If I work hard I can increase my mathematical ability.					
If I don't know the answer in Maths I know what to do to find out.					
If I don't understand the question in Maths I know what to do to find out.					
I am confident in my mathematical ability.					

Section 2

What do you do when you get stuck in Maths lessons?

………

………

………

………

What do you do when you get stuck with your Maths homework?
………
………
………
………
What do you do when you get an answer wrong in Maths?
………
………
………
………
What do you do if you do not understand the meaning of a Maths question?
………
………
………
………

Section 3 - Please indicate how anxious (worried/stressed/nervous) the following areas of Mathematics make you feel. Please tick one answer for each statement.

	Very anxious	Anxious	A little anxious	Not at all anxious
The words used in the questions.				
Going to Maths lessons.				
Looking through the pages in a Maths text book.				
Receiving Maths questions that you do not immediately know how to do.				
Thinking about a Maths test/assessment.				
Answering a question in front of the class (in Maths).				
Taking a Maths test/assessment.				
Reading and interpreting graphs or charts.				
Questions involving mental arithmetic (working it out in your head).				
Long written questions.				
Completing Maths homework.				
Following your teacher’s explanation in class.				

Section 4 - On a scale of 1 to 10 how maths anxious are you? Please circle one answer. (Ashcraft 2002)

1	2	3	4	5	6	7	8	9	10

Not at all anxious Very anxious

Section 5 -Please indicate any particular areas of Maths that make you anxious (worried/stressed/nervous).
………
………
………
Thank you for completing this questionnaire.

Appendix 2. Pre interview questionnaire

Your interview regarding your feedback of your mathematics peer mentoring sessions will take place at …… It will last approximately 20 minutes.

Before your interview please answer the following questions and return this to the researcher in the Maths Office.

What about your peer mentoring sessions worked particularly well? (E.g. tasks, mentor, timetabling, resources)

……

……

……

……

What about your peer mentoring sessions did not work particularly well?

……

……

……

……

Did your student request/initiate any topics? If so, what were they? *(Included only for the mentors)*

……

……

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……

Please describe how you selected what to work on during each session.

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……

Please describe any prompts/questions/tactics that worked well with your student during the sessions.

……

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……

……

Can you suggest any amendments/improvements/hitches?

……

……

……

Thank you for completing this questionnaire.

Appendix 3. Semi-structured interview questions

Semi-Structured Interview Questions for the Students
Please be honest and take your time to think of your response, there are no right or wrong answers. Your responses will be kept confidentially and remain anonymous. Please do not use any names. This interview will be recorded but please be assured it will be deleted after I have made my notes.

About them.
What did you learn about how to handle work in maths?
During your sessions, have you learnt anything that you have used in your maths lessons? If so, could you please describe what?

About the intervention.
What about the intervention was helpful?
What about the intervention was not helpful?
What do you think about … ?

- The length of the sessions.
- The number of sessions.
- The tasks set.
- The instructions given.

When this intervention is repeated with other students, what should be done differently?

About the mentor.
How did you feel having a peer mentor to support you?
Did your mentor do anything that helped you in particular?
Did they do anything that was not helpful?
Would you partake in this research again now knowing what it involves? If not, why not?
Is there anything else you would like to add? If so, what?

Appendix 4. Semi-structured interview questions

Semi-Structured Interview Questions for the Peer Mentors
Please be honest and take your time to think of your response, there are no right or wrong answers. Your responses will be kept confidentially and remain anonymous. Please do not use any names. This interview will be recorded but please be assured it will be deleted after I have made my notes.
What worked well about your peer mentoring sessions?
Was there anything they responded particularly well to?
Did anything not work well?
How did you find working with your student?
What did you think about … ?

- The length and number of sessions.
- The work provided (and specifically the terminology task).
- The resources available. (What did you use?).
- The clarity of the instructions provided.
- The briefing you received.
- The way you gave feedback.
- The support you received.

Did you learn anything from the sessions? If so, what?
Is there any information that you wish I had told you before the Intervention took place?
When this intervention is repeated with other students, what should I do differently?
Would you partake in this research again now knowing what it involves? If not, why not?
Is there anything else you would like to add? If so, what?