

## **Exploring mathematics anxiety amongst pupils at a pupil referral unit**

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This research explored the prevalence, origins and expression of mathematics anxiety amongst students at a pupil referral unit (PRU). Eleven students were screened for mathematics anxiety using a questionnaire designed for this purpose. Five students scored highly for mathematics anxiety and the three highest scoring students were selected for interview about their experiences in mathematics classes both in the mainstream and PRU settings. Five themes emerged from thematic analysis: teacher input; negative lessons; subject matter; lack of personal empowerment; and the testing nature of mathematics lessons.

**Keywords: mathematics anxiety; social, emotional and mental health [SEMH]; pupil referral unit [PRU].**

### **Mathematics Anxiety**

This research was carried out in a pupil referral unit (PRU) in the South of England, where I work as a one-to-one mathematics tutor. The students are both male and female and aged from 11-16. Students come to the unit when they have been excluded from mainstream schools or cannot cope in mainstream for a variety of reasons.

Jones Bartoli (2018) asserts that many social, emotional and mental health (SEMH) students have experienced difficulty and trauma in their home lives and suggests that these students are often highly alerted to threat in their environment. I wanted to explore if mathematics anxiety was playing a part in the threat that our PRU students might feel in the classroom.

Mathematics anxiety has been defined as involving “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems” (Richardson & Suinn, 1972, p.551). Such feelings will clearly have a negative impact on the mathematics learning experience of a student and may well affect them in their everyday lives (Maloney & Beilock, 2012). Indeed, it has been shown that mathematics anxiety can lead to lower achievement and has a significant bearing on the number of students avoiding mathematics altogether (Hembree, 1990).

The issue of whether mathematics anxiety leads to poor mathematics performance or whether poor mathematics performance leads to mathematics anxiety is prevalent in mathematics anxiety research (Carey et al., 2016). That mathematics anxiety is linked to poorer mathematical performance, is not really in question (Carey et al., 2016), however studies trying to establish the direction of the link do not always reach the same conclusions (Devine et al., 2012). Two theories predominate: the Deficit Theory suggests that poor performance in mathematics leads to higher anxiety; the Debilitating Anxiety Model suggests that mathematics anxiety inhibits performance by affecting the pre-processing, processing and retrieval of information (Wine, 1971; Tobias & Deutch, 1980; Tobias, 1986).

Evidence exists to support both the Deficit Theory and the Debilitating Anxiety Model. This leads to Carey et al. (2016) suggesting that a vicious cycle may

exist, whereby poor performance leads to mathematics anxiety, which can then further hinder performance (because the student avoids mathematical situations or has their working memory impaired). However, initial poor performance may start from a predisposition to anxiety and lead to the same cycle. This is known as the Reciprocal Theory and was suggested by Jansen et al. (2013).

### **Determining mathematics anxiety at the PRU**

For this research, students at the PRU were asked to complete a questionnaire based on the Math Anxiety Scale (MAS) by Betz (1978). The questions were adapted by Baker (2019) for similar research in a mainstream secondary setting. The questionnaire consisted of ten questions answered on a five-point Likert scale. A score above 32 shows a visibly high level of mathematics anxiety and scores above 27 demonstrate mathematics anxiety that is not necessarily visible.

Unfortunately, due to Covid 19 restrictions, only 11 questionnaires were completed as few students attended the PRU during lockdown.

The questionnaire scores show that four participants scored a result of 32 or above, indicating a high and visible level of mathematics anxiety and one further student scored above the anxiety threshold of 27.

The results show that 36% of this sample group have high levels of mathematics anxiety. This is higher than the 25% prevalence of high levels of mathematics anxiety that Baker (2019) found in a mainstream secondary school. Interestingly, my results split the students into two categories: either highly maths anxious or not maths anxious at all. Unlike in Baker's (2019) results there were no scores in the mid-range. This could be something that is specific to the PRU setting or could just be the consequence of a limited data set.

### **Interviews**

From the questionnaire responses, the three students demonstrating the highest mathematics anxiety were invited for interview. These students were two girls and one boy, whom I will call Rosie, Lillie and Nathan. Covid 19 restrictions prevented me from conducting the interviews personally, so they were carried out by a colleague and audio recorded.

I transcribed the interviews and then conducted a thematic analysis, as outlined by Braun and Clarke (2006). The transcripts were coded, and a thematic map emerged from the data. The main themes were: teacher input; negative lessons; subject material; lack of personal empowerment; and the testing environment of the mathematics class.

### **Teacher input**

All three participants indicated that mainstream mathematics lessons were different to mathematics lessons in the PRU and gave the impression that mainstream mathematics lessons created more anxiety.

Nathan suggested that: "Mainstream's more people so I feel more worried and nervous about asking for help because there's like thirty kids in the class". He went on to add that in the PRU there were only three people in the class, and he was friends with them, so he did not mind asking for help.

Rosie made it quite clear that she hated mainstream mathematics lessons and then went on to explain that she would get distracted when she did not get help. Her

view was that she did not get help from the teacher because of her behaviour but that her behaviour was a result of things going on at home. She concluded that she felt a bit left out, especially as she had to sit alone in the back of her mainstream mathematics class.

All three students suggested that there were some aspects of mathematics where they were able to get on with the work on their own but there are always times when they could not move on without further teacher input. This input would relieve some of their anxiety but since they were not confident about asking for help, they required it to be offered in a timely manner in order to eliminate the need for a public request for help.

### **Negative Lessons**

Rosie was able to recall exactly when her mathematics anxiety first started. She described a “times tables mountain” from her year 3 class where you had to get to the top. This was significant for her as she wanted to impress her Dad with her achievement. She had clearly felt that this was of utmost importance, over and above her other schoolwork, in order to make her Dad proud. This led to extreme anxiety, culminating in a panic attack at the age of only eight years old.

Lillie and Nathan had differing views on being in a larger mainstream classroom. As already mentioned, Nathan felt anxiety asking for help in mainstream mathematics lessons. Lillie, on the other hand, felt that she was less likely to be “picked on” in a large class. This would suggest that for Lillie, mathematics lessons were all about avoiding having to answer questions, which must mean that she has this as a continuous anxiety present throughout her mathematics lessons.

Rosie also used the phrase “picked on” to describe her experiences of mainstream lessons but she asserted that this was because she struggled with the lesson content. Interestingly, Rosie mentioned that she felt out of her depth in a mixed ability setting and that this added to her anxiety.

### **Subject Material**

The mathematics in lessons was categorised by all three students as being either easy, so they could just get on with it, or too difficult for them to make any progress unaided and thus causing anxiety. Nathan referred to questions as “the hard ones” and stated that he got “proper nervous” and “stressy” when the questions were hard. Lillie described the difficult work as being such that “I just don’t get it.” Rosie described how she felt that she did not have any strong points in the subjects that make her anxious, telling herself that she is not smart enough and making herself feel dumb.

Nathan’s comments suggest that it is the nature of the mathematics questions that cause him stress rather than a lack of understanding, whereas Lillie and Rosie assume that any inability to cope with the subject content must be a failing on their part.

Mathematics for these three students does not come across as a creative subject where they can explore their ideas. They appear to view it as a series of questions that they can either complete easily or require help.

### **Lack of Personal Empowerment**

Nathan and Lillie both responded that nothing would help them to feel less anxious when doing mathematics. Lillie explained that her coping strategy at the PRU was to

walk out of the classroom or to tune out if she doesn't "get it". Rosie linked her mathematics anxiety with her mental health generally and did not necessarily see any distinction between the two.

All three participants talked about mathematics they could do and mathematics that they needed help with. The two situations seemed to be polarized such that there was no possibility for the students to work through harder problems utilising methods and ideas that they had met before.

### **Anxiety in tests**

Nathan used the words "nervous", "worried" and "stressed" to describe his feelings about mathematics tests. McDonald (2001) states that fear of exams and test situations is widespread. He suggests that this may be due to the frequency of testing and the importance placed on testing within education systems. Boaler (2009) draws attention to the high stakes testing in UK schools and it would seem likely that this situation is only set to continue with the introduction of further testing of year 4 students (8- to 9-year-olds) on times tables.

Boaler (2009) also highlights the argument from the Mathematical Association that testing and test preparation result in less interesting and less challenging problems. Therefore, mathematics is taught in a limiting way and additional high stakes testing is leading it to become associated with test anxiety. These limitations are perhaps evidenced by this research where all three students viewed the subject as being about questions that are either easy or impossible to answer.

### **Anxiety in lessons**

McDonald (2001) describes a test situation as being "an evaluation" (p.90). It struck me that Lillie's perspective of avoiding being "picked on" to answer a mathematics question in class, means that she sees every question asked in the class as an evaluation and viewed every mathematics lesson as a test of sorts. In Lillie's case, the testing in lessons was something that she wished to avoid.

McDonald states that test anxiety is most closely associated with the American Psychiatric Association classification of social phobia where the individual "shows attempts to avoid the social or performance situation, or sometimes endure it but with extreme fear" (APA, 1995 p.422). Certainly, Lillie had times when she wished to avoid situations in a mathematics lesson as she states that: "If I don't get it...I just either walk out or I just, like, tune out a bit."

Lillie's wish to hide within a mainstream mathematics class suggests that she does not feel confident that she would be able to answer any questions that she might be asked. It is hard to judge if this is mathematics anxiety or test anxiety. It may well be both.

### **Trauma**

The headteacher at the pupil referral unit confirmed that many of the students have suffered from some form of trauma in their lives. Horsman (2000) concludes that a chaotic home life can restrict the opportunities for a student to see how "regular effort leads to results" (p.81). Therefore, it is vital for the student to be able to cognitively engage with the mathematics at a starting point where they feel confident in order for them to see progress as a result of their efforts. This starting point must be carefully considered, however because, as Rosie states, the work in her mathematics lesson is

often very easy. This means that she does not have the opportunity to experience progress in her mathematics learning.

### **Zone of Proximal Development**

All three participants interviewed for this research suggested a gap, perhaps even a chasm, between mathematics that they could do and mathematics that they could not do. For example, Nathan says, “If they’re hard ones I get proper nervous, stressy. If they’re easy then I do ‘em.” This suggests that the zone of proximal development (ZPD), as defined by Vygotsky (1978), needs careful consideration when moving students to the next level of their learning.

Eun (2019) explains that to be within the ZPD, the teaching must focus on the material that the learner is ready to develop with the assistance of a teacher or a peer. Also, the ZPD should focus on social transformations whereby individuals work together to obtain new understanding.

Consequently, when Rosie recalled that she had to sit on her own at the back of the mainstream classroom, she had been excluded from interactions with her peers that could have been vital to her cognitive development. In this situation, Rosie was then totally dependent on the teacher and yet she felt that the teacher did not help her.

Nathan and Lillie also made it clear that talking in front of a class of 30 was too daunting. If they were not given the opportunity to discuss their ideas with peers, then they too were being denied the oral support from their peers that would help to develop their ZPD. This would suggest that mathematically anxious students would benefit from working in smaller collaborative groups.

At the PRU, Rosie brought to class her mathematics anxiety and a desperate need for oral communication. Unfortunately, she found it hard to discuss her mathematics with the teacher as they were often distracted by the behaviour of others, leaving her to report, very sadly, that: “I feel a bit, like, abandoned.”

### **Conclusion**

Approximately a third of this sample from a PRU showed high levels of mathematics anxiety, which is higher than we would expect to see in mainstream secondary schools.

The three students with the highest levels of mathematics anxiety conceived of mathematics as consisting of questions that were either easy or too hard to attempt on their own. When they perceived questions as hard they wanted input from their teachers, but often found this hard to get, creating a source of mathematics anxiety. When questions were easy, the students were not learning anything. Consequently, careful consideration has to be given to the difficulty of the questions given to these students and how to support them to make progress without increasing their anxiety.

Tests were another source of anxiety. Perhaps less obvious than tests, is that these students perceived the questions that are asked in a normal mathematics class as a testing environment. In a mainstream setting, careful consideration needs to be given to how questioning in the lesson is approached. If Lillie and Nathan are sitting in a classroom and experiencing anxiety, then this is using up working memory that could be better used for thinking about the mathematics.

One of the biggest challenges for students at the PRU is that they have faced some form of trauma in their lives. It would seem essential, therefore, to provide a mathematics classroom environment where students feel relaxed and not threatened in any way by the mathematics that they are being asked to do.

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