

Measuring and Improving **Mathematical** Resilience in Students



Richard **Butterfield**

 @MathsResilience

About me

Studied BSc Mathematics at University of Bath, and then completed MA in Education with a dissertation focussed on Mathematical Resilience.

Qualified as a mathematics teacher in 2011.

Total teaching experience – 10 years; 7 years in the UK and 3 years in Japan.

Currently teaching at ACS International School Cobham.

Taught KS3, GCSE, A-Level, as well as IB MYP and DP at both HL and SL.



Why focus on Resilience?

There is a focus on preparing students for the future – resilience of the unknown should be part of this. There has also been more of a focus on the mental wellbeing of students in schools.

Resilience in mathematics shows a willingness to try to solve problems that are unknown to an individual – much like the problems or jobs that may exist in the future that we do not know of yet.

What is Mathematical Resilience?

Maths, more than any other subject, has the power to crush children's confidence (Boaler, 2009).

Mathematical Resilience is a positive adaptation that allows people to overcome barriers that frequently present themselves when learning mathematics.

There has been an increasing amount of research into mathematical resilience and it was included in questionnaires run by the international testing agency PISA in 2013 (OECD, 2013), and is part of the TIMSS questionnaires taken every four years (latest was in 2019 – results not available yet).

Boaler, J., 2009. *The elephant in the Classroom: Helping Children Learn and Love Maths*.

Johnston-Wilder, S. and Lee, C., 2010. *Mathematical Resilience*. *Mathematics Teaching*, 218, pp. 38-41 (www.mathematicalresilience.org)

OECD, 2013. *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy*

Trends in Mathematical Resilience

As students get older:

- Student attitudes towards mathematics become **more negative**
- Engagement with mathematics **decreases**
- Students get **less confident** in their abilities in maths
- **Less students** state that maths is their favourite subject

What can be done about it?

“

Most of my work as a math teacher isn't even math.

**IT'S HELPING STUDENTS
BELIEVE THAT THEY
CAN ALSO DO MATH.**

We don't talk about that enough.

—
JOSÉ VILSON, TEACHER

edutopia

It's easy to get bogged down in teaching content to pass an exam.

Being aware of student attitudes towards mathematics can help you to target your teaching more effectively – this will in turn lead to improved progress for students.

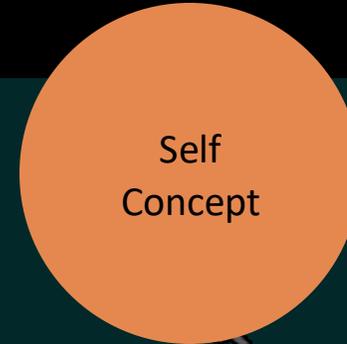
The seven characteristics of resilience

I defined seven aspects of mathematical resilience.

I developed these from PISA's four measures of drive and motivation towards mathematics, alongside five measures of self beliefs for the reasons behind studying mathematics.

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Self Concept



This area looks at whether participants are confident in their mathematical abilities.

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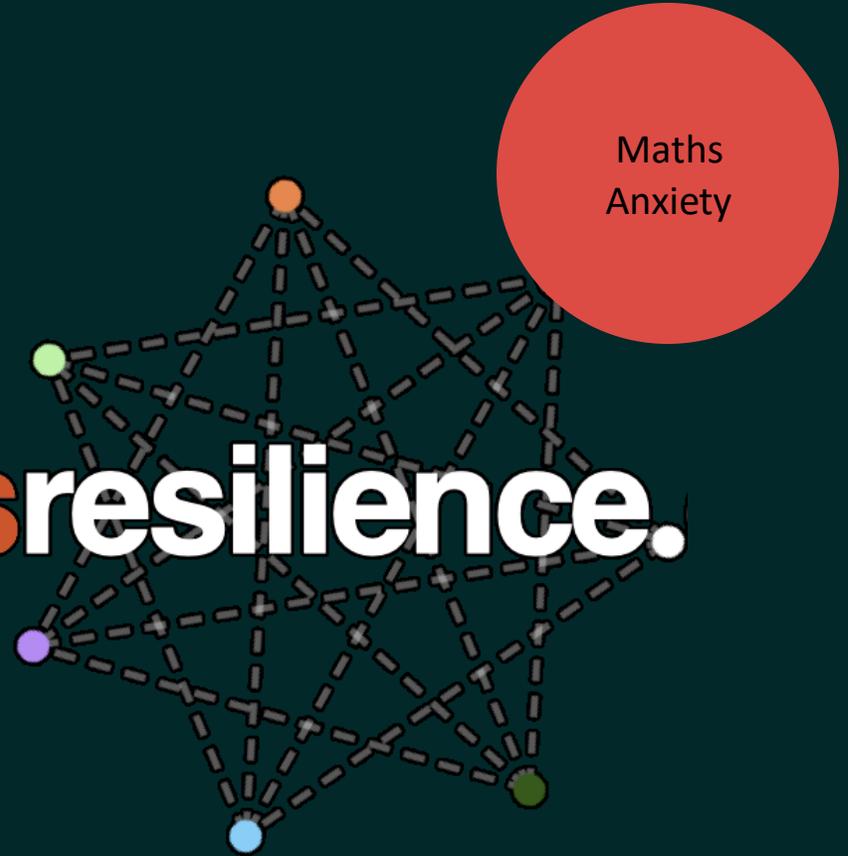


Maths Anxiety

Whether students feel stress or a sense of helplessness when carrying out mathematics.

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Maths
Anxiety



Mathematical Dispositions

How those who are close to the participant feel towards mathematics, for example their parents or their peers.

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Mathematical
Dispositions



Problem Solving & Perseverance

Whether students have confidence in continuing a problem that may appear difficult, as well as being open towards mathematical problems to which they may not know the method or solution.

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Problem
Solving &
Perseverance

Locus of Control

Whether the participant attributes success or failure in mathematics to themselves or to some external influence.

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Locus of
Control

Motivation

This looks at both intrinsic (enjoyment of the subject) and instrumental (belief in usefulness of the subject) motivation towards wanting to study mathematics and whether they are engaged in the process.



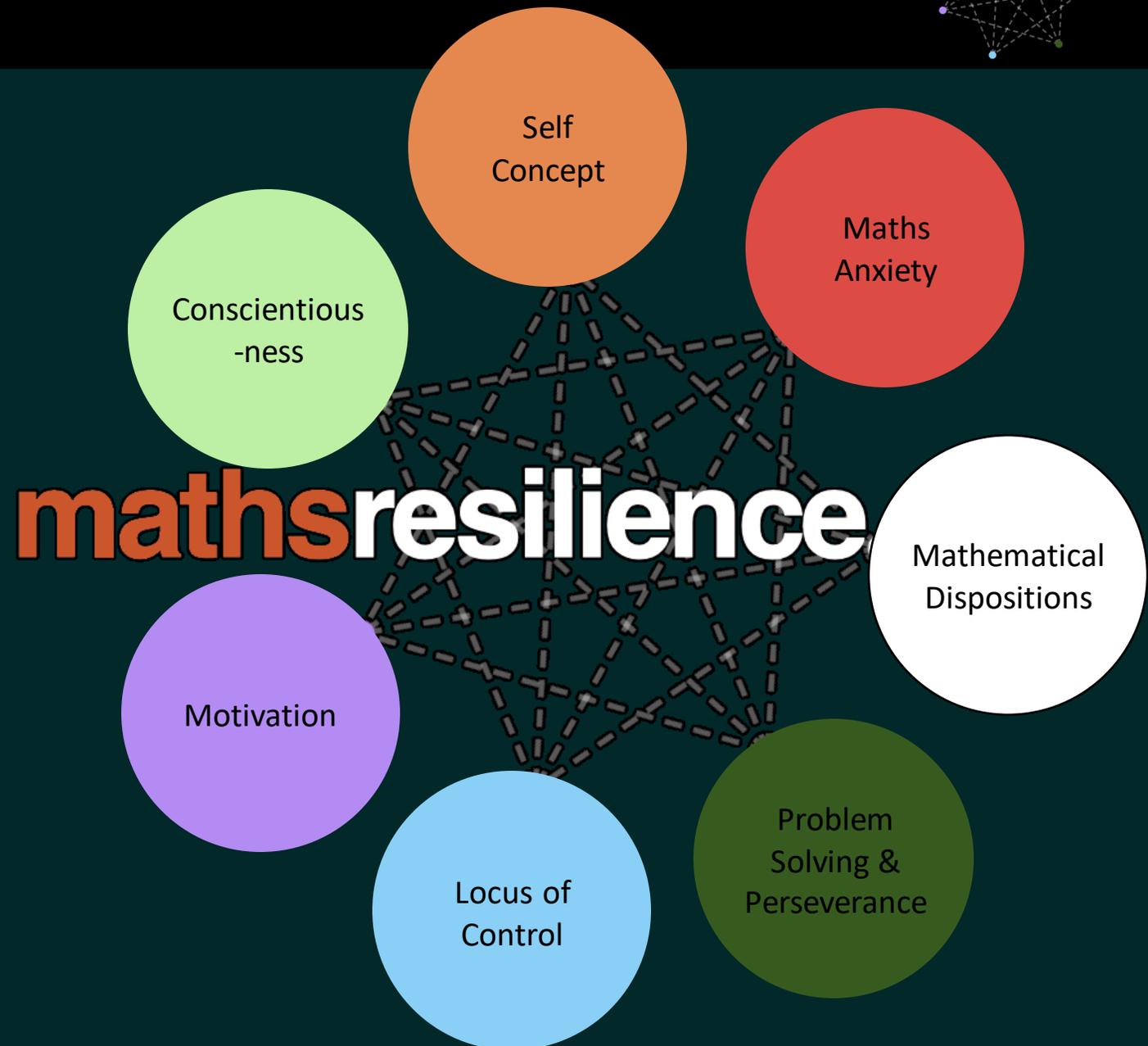
Conscientiousness

Whether students care about their own learning in mathematics lessons as well as homework, or whether they help their friends in mathematics.



The seven characteristics of resilience

Just having teachers and students aware of these seven characteristics can help improve learning in and outside of class.

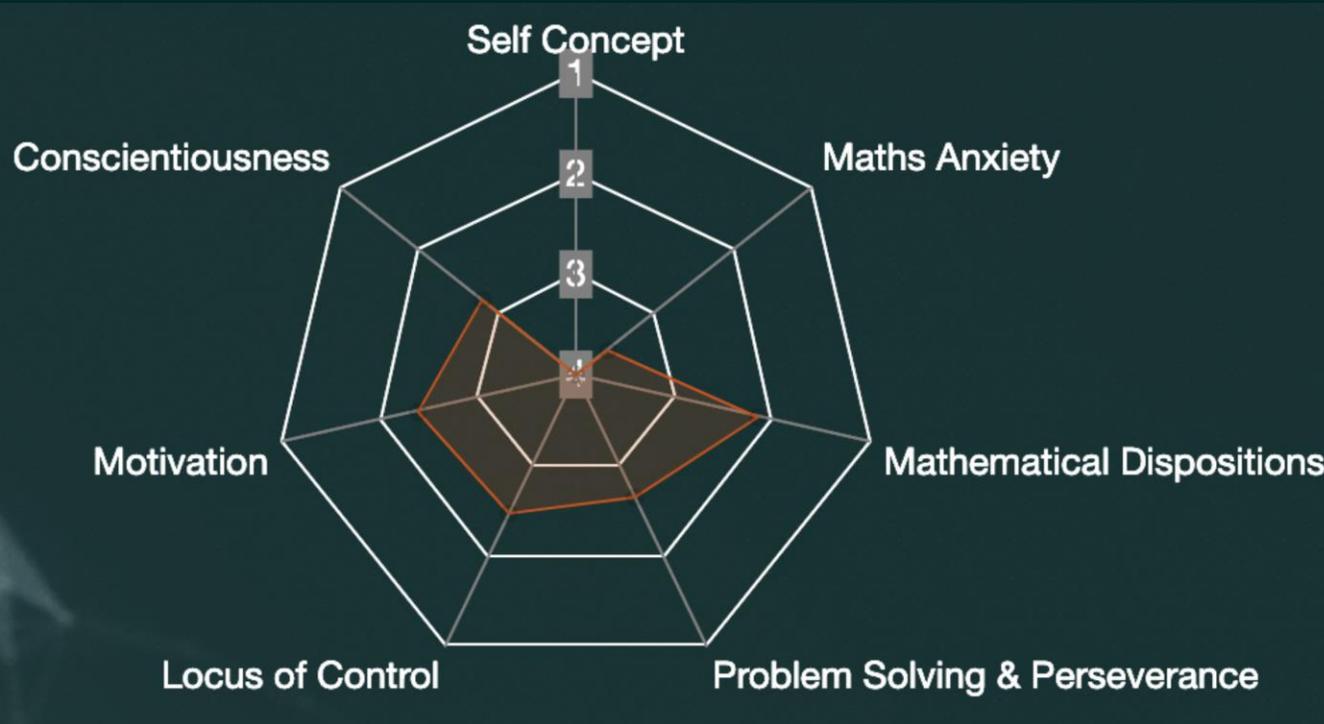


Problem...

I had a student who found maths difficult, and they had low confidence in the subject. I had tried my usual differentiation and encouragement techniques, and no noticeable improvement was seen in her attitude.

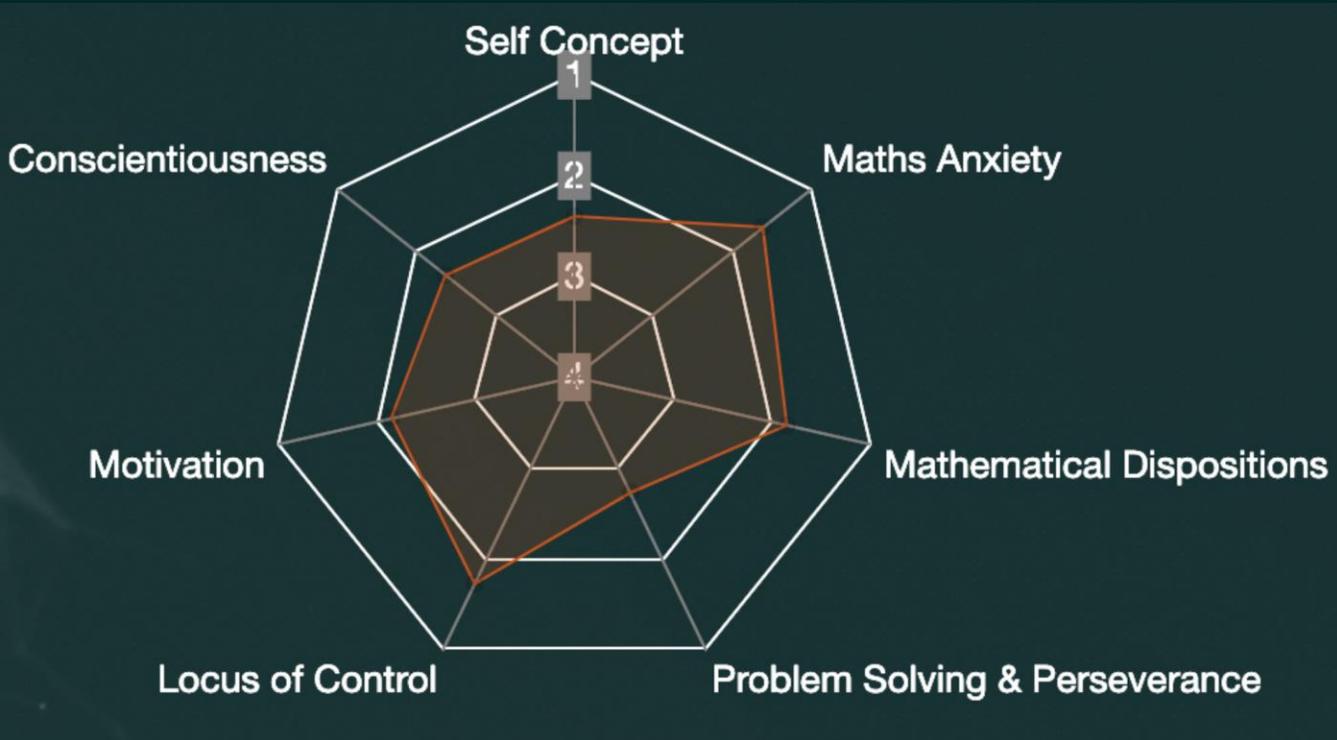
I remembered about the research I had done a few years before, and asked the student to complete it.

Example



Year 10 female student took the questionnaire in November 2018.

Example Student



6 months later...

The Questionnaire

The questionnaire is based upon the questions found in the PISA 2012 and TIMSS 2011 survey asking students about their attitudes towards mathematics.

Students select how much they agree or disagree with a given statement, on a scale from 1-4 (or 1-5).

Each question is placed into one of the categories of Mathematical Resilience to give an overall score in that area of resilience.

There are 59 questions in total to be answered.

Can this be applied on an individual student level?

Would students and teachers find this information useful, and could it be used to try to improve students' mathematical resilience in the classroom?



Page 1 of 5 - About studying Mathematics

To what extent do you agree with the following statements?

I enjoy learning about mathematics.

Select your answer

I look forward to my mathematics lessons.

Select your answer

Learning mathematics is worthwhile for me because it will improve my career prospects.

Select your answer

Mathematics is an important subject for me

Making an effort in mathematics is worth it because it will help me in the work that I want to do later on.

Select your answer

I do mathematics because I enjoy it.

Select your answer

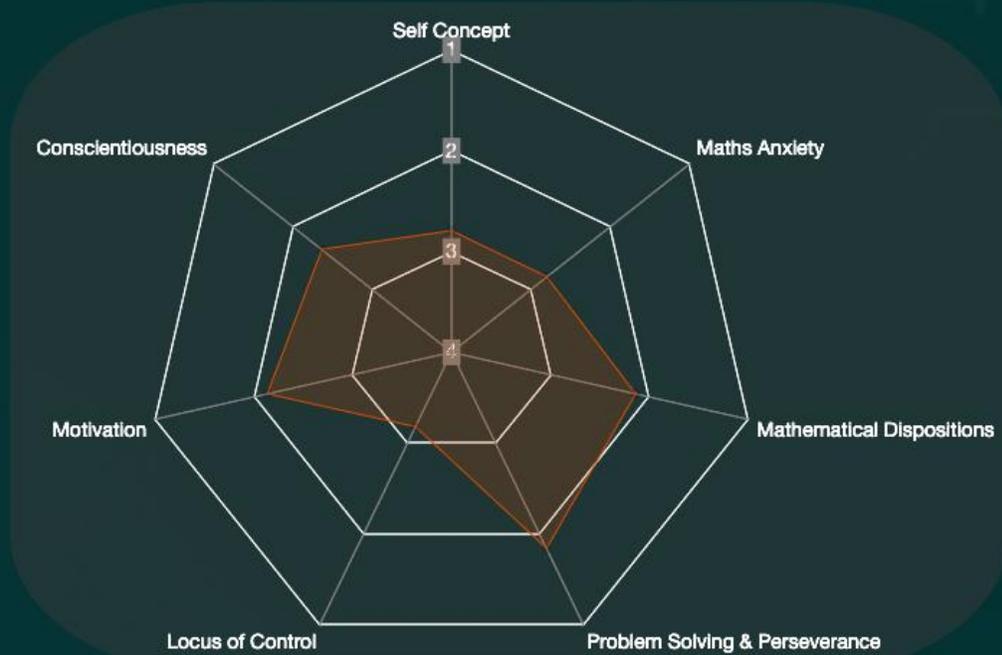
I am interested in the things I learn in mathematics.

Select your answer

What Students See

Date	Self-Concept	Maths Anxiety	Mathematical Dispositions	Problem Solving and Perseverance	Locus of Control	Motivation	Conscientiousness
30/07/2019	2.8	2.8	2.14	1.84	3.18	2.13	2.36

A score closer to 1 shows that you are strong in this aspect of mathematical resilience.



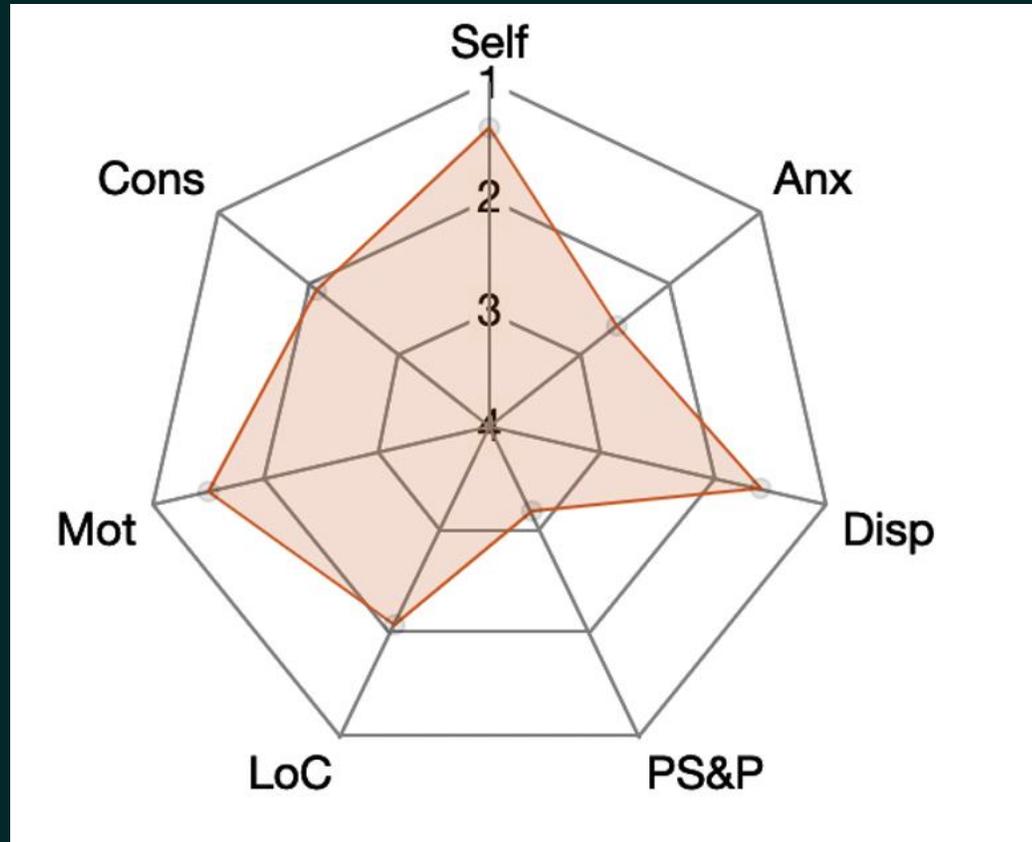
	Score	What your score means	Possible strategies to improve your score
Self Concept	2.8	You have some belief that your abilities in mathematics is good, and this is likely to be in some topics rather than others.	Take note of when you have successes in mathematics to build up your confidence in the subject.
Maths Anxiety	2.8	You get nervous about mathematics on certain problems, more likely those that you perceive to be more difficult.	Being stuck on a maths problem is not a bad thing, it happens to everyone. Give yourself a little longer to work on maths problems.
Mathematical Dispositions	2.14	Your peers and others around you have differing opinions on mathematics, some positive and some negative. You also have mixed feelings about the subject.	Seek out positive role models for mathematics in your school, or local community. Watch YouTube videos of people talking about maths if this is difficult to do.
Problem Solving & Perseverance	1.84	You enjoy solving problems, even when you get stuck on them you continue to work on it and don't tend to give up on the problem.	Break long problems down into shorter steps. Look at how the knowledge you have can be used in other ways, such as answering maths challenge questions, or solving other puzzles.
Locus of Control	3.18	You have a belief that your mathematical ability is not in your control, and look for other factors when you are both successful and unsuccessful in mathematics.	Try to keep track of when you are successful in mathematics, and give yourself the credit for it. When things don't go right, see what you can do to improve.
Motivation	2.13	You see some usefulness in mathematics and have some motivation to want to do well in the subject. There are some occasions where you do not feel this way.	Look out for when maths is used everyday, as well as in careers or courses you may look at doing in future.
Conscientiousness	2.36	You take some care in your mathematics work, and on occasion talk about mathematics with others.	Try to stay on top of your notes and homework in mathematics. Make sure that you are laying out your workings in a logical way.

Class View



The questionnaire outputs a graph that is instantly available to students. Teachers can access the result as soon as the student completes the questionnaire.

More examples



This is a student in a middling prior attainment set.

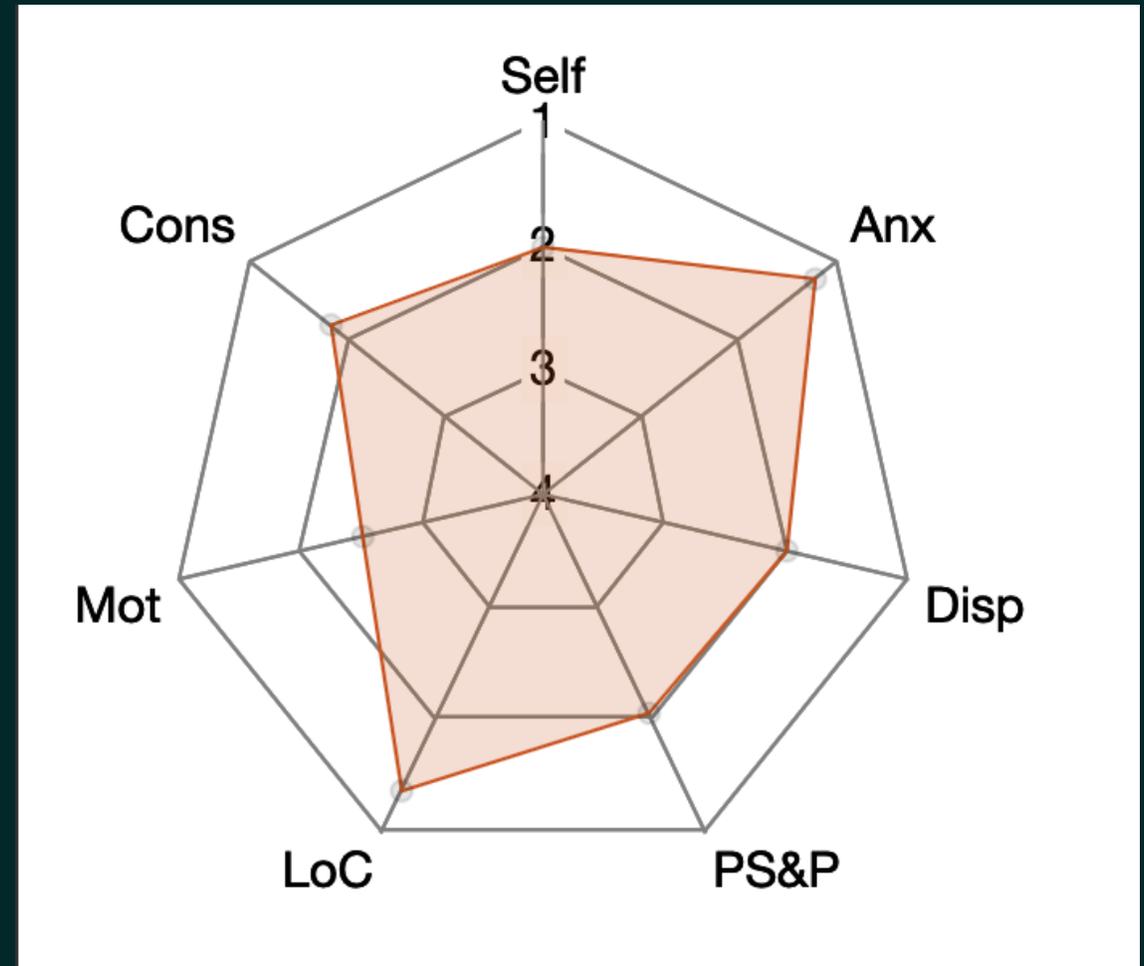
What does this student's resilience score tell us?

How can we support and help this student to improve?

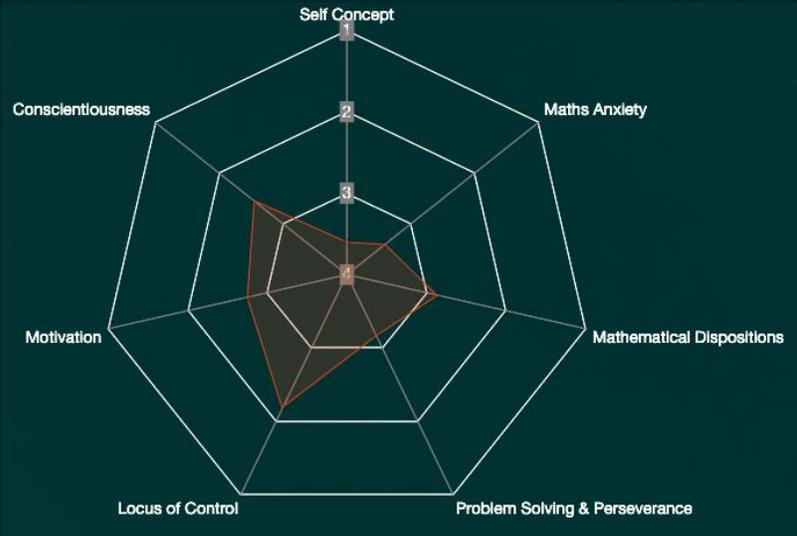
Another example

This student is a student in a high prior attainment group.

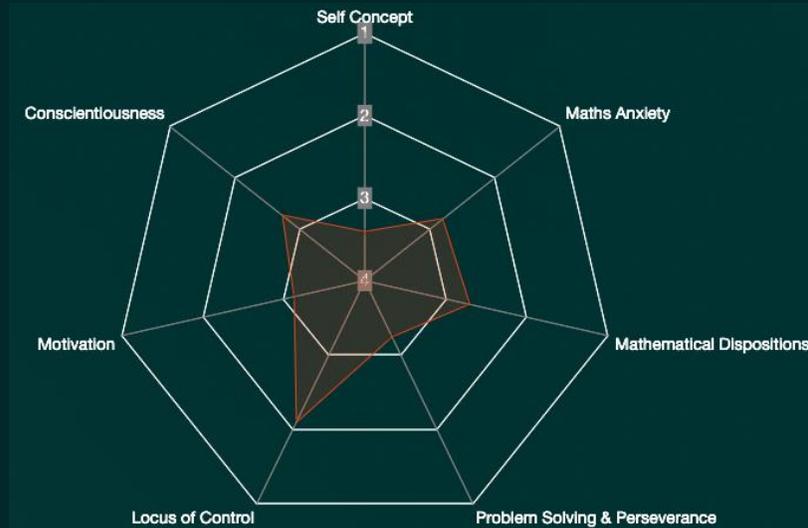
What can we do to support this student?



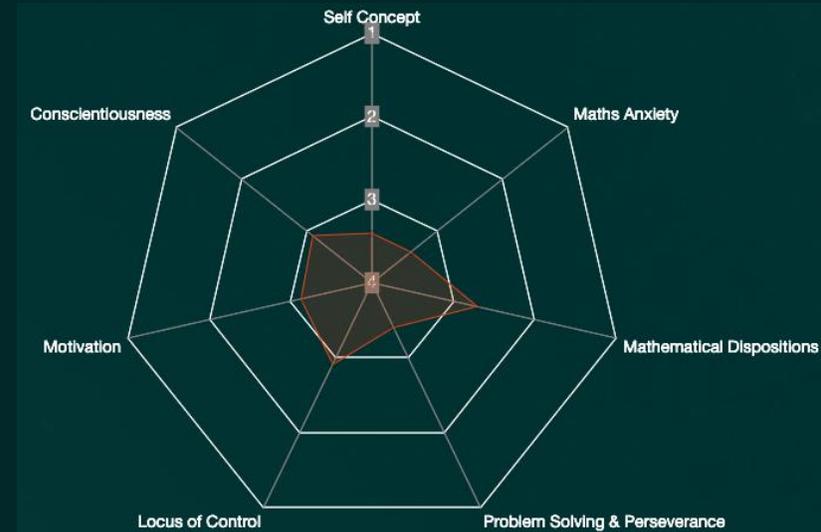
One Student this year



August 2020



March 2021



June 2021

Summary

Whilst it was shown that students get less mathematically resilient as they get older, the mathematical resilience of students is actually fluid, and can change dependent on recent events.

There are seven areas of mathematical resilience that affect a person's performance in mathematics.

Improving a student's mathematical resilience will allow that individual to improve. Even a student in a high attainment set can have a characteristic of mathematical resilience that they could improve in.

Now what?

You can set up your school on mathsresilience.com for free, and get students to complete the questionnaire to see their mathematical resilience levels.

When you have the results, think about how you have been interacting with that student, and how you could change your habits to improve their mathematical resilience.

Have students retake the questionnaire at different points of their maths journey – start of the year, after Christmas, end of year.

I will be creating and sharing resources that focus on improving a particular area of resilience over the coming weeks.

References and Further Reading



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