Some things to think about!

1 The answer is 42. What is the question?

2 Put three coins on a table all showing heads. Is it possible to make them all tails by turning two at a time? Try different numbers of coins.

3 How can you use four of the digit 9 and any of +, −, x and ÷ to make 100?

4 How many numbers between 10 and 99 inclusive contain different digits? (For example 36 has different digits but 33 doesn't.)

5 The chances of winning the lottery with 6 correct numbers is the same as naming a particular second from a period of 4 months. Is this true?

6 Small oranges cost 8p each, large oranges cost 13p each. Some oranges are bought and the bill is exactly £1.00. How many of each size of oranges are bought ?

7 If you had a set of ten cards numbered 0 to 9, could you make six numbers which are all multiples of three? (This means numbers like 3, 6, 78, 105 etc. which are something multiplied by three.)

8 Which is the smallest number that you cannot score with 3 darts which all hit the dartboard (other than 1 and 2)?

Mathematical Resilience

Boolean Hub Conference 2019

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We’ll start with some maths – try to think about how you feel as you work on the problem;

- Is this really possible?

2 Pumps

- 3 large pumps and 2 small pumps take 4 hours to empty a swimming pool;
- 1 large pump and 3 small pumps take 10 hours.
- How many small pumps would it take to empty the pool in 5 hours?
- How long would it take 4 small pumps to empty the pool?

Initial Question

"How do you feel when you are trying to do a problem in maths and at first you cannot do it?"

Second Question

"What feelings and internal processes help you to remain engaged, and are helpful to solving the problem?"

Feelings needed to become motivated and resilient?

- S*ense of frustration and annoyance* when first faced with a problem which one cannot do.
- An *expectation* that they will have to spend time thinking about the problem before they solve it, and that it might be hard.
- A *belief* that they will be able to ‘get there in the end’.
- A strong *want or need* to work the problem out themselves.
- A selection of *strategies* to help them to get there (e.g. ‘draw a diagram’, ‘ask a friend what they did’, ‘list what you know and need to know’, etc…)

Growth Zone Model

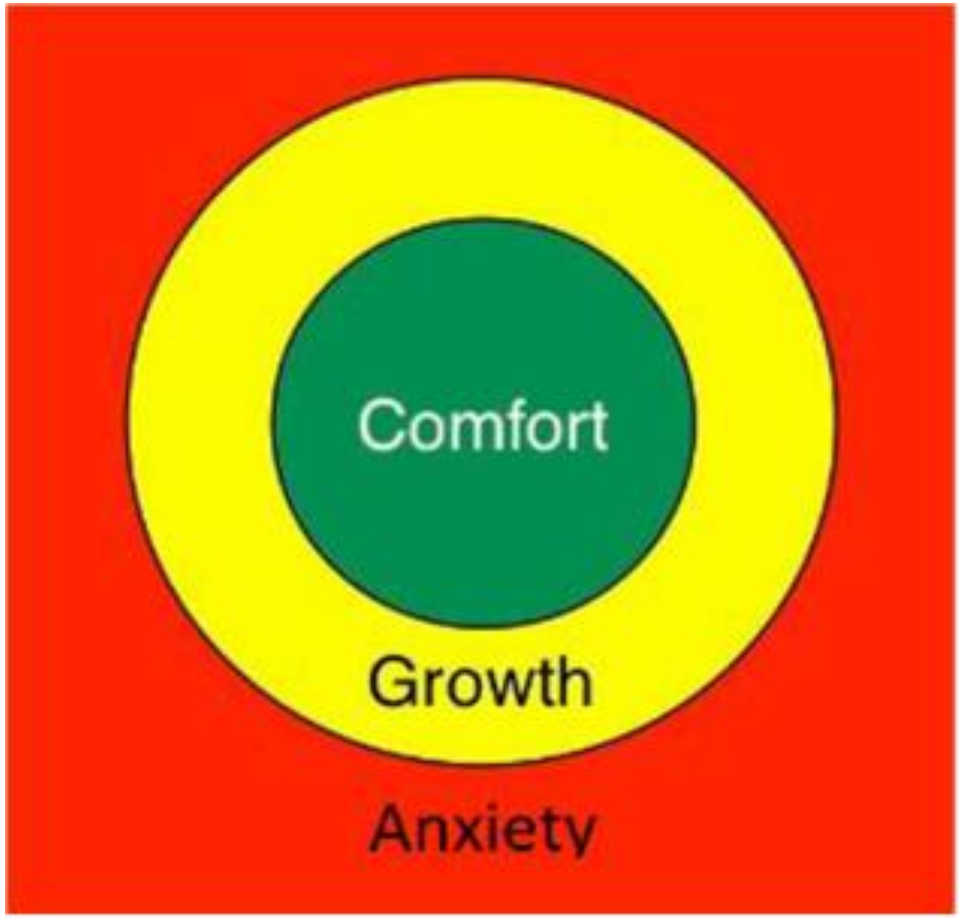


Figure 1: The Growth Zone Model

Mathematical Resilience

- Perseverance;
- Ability to work collaboratively;
- Express oneself;
- Motivational beliefs;
- Malleable self-theory of learning (growth mindset);

4 Dimensions

1. **Growth:** developing an incremental theory of learning mathematics (mindset).

2. **Value:** those who develop mathematical resilience understand and experience that mathematics is important in society and also to them personally – thus those who wish to help others develop mathematical resilience must enable learners to see mathematics around them. This aspect is also about the value of the individual as part of the mathematical community. Everyone who engages with mathematics is a valued part of the inclusive community and adds value to it.

3. An understanding of **how to work at mathematics**: that progress in mathematics requires struggle, curiosity and persistence as well as learning to manage the emotions that come with learning something new.

4. Knowing **how to recruit support**. This requires an awareness of the value of collaboration to aid in the struggle to grow mathematical knowledge, skills and understanding. Thus when working at mathematics, both the giving and receiving of support is important. This aspect also incorporates the wider community of mathematics, through the internet or textbook or more knowledgeable others.

Teacher strategies to help build resilience?

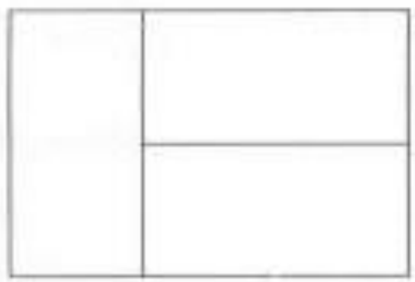
- Gently, gently – build confidence and trust you to give them work they will be able to access – they must experience success, and trust you!
- Develop this self-trust by trying to avoid giving answers to problems so that students do not develop a ‘learned helplessness’ (Dweck).
- Focus on teaching the strategies, and being explicit in this.
- Do not compare students’ abilities or tell them that you expect them to be able to do things easily, or find them hard.

More Questions!

- How to measure mathematical resilience in a more objective way?
- What extra obstacles are there to developing mathematical resilience with Post-16 students who have always found maths easy?

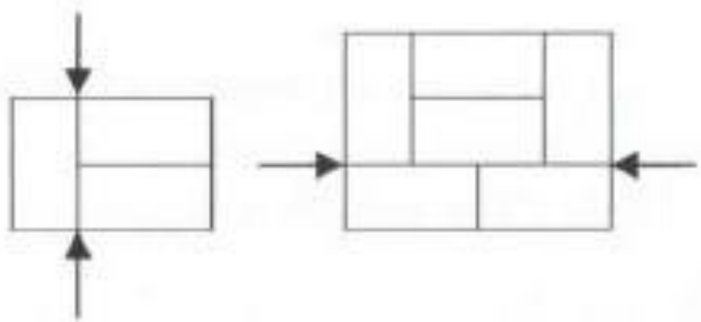
5. Fault Lines

Here is a rectangle made with some dominoes.



Each domino is a 2×1 rectangle

A fault line is a straight line joining opposite sides of the rectangle. These two rectangles both have one fault line.



What is the smallest fault free rectangle that you can find?
What is the smallest fault-free square?
Suppose you use 3×1 rectangles instead of dominoes?

Growth Zone Model

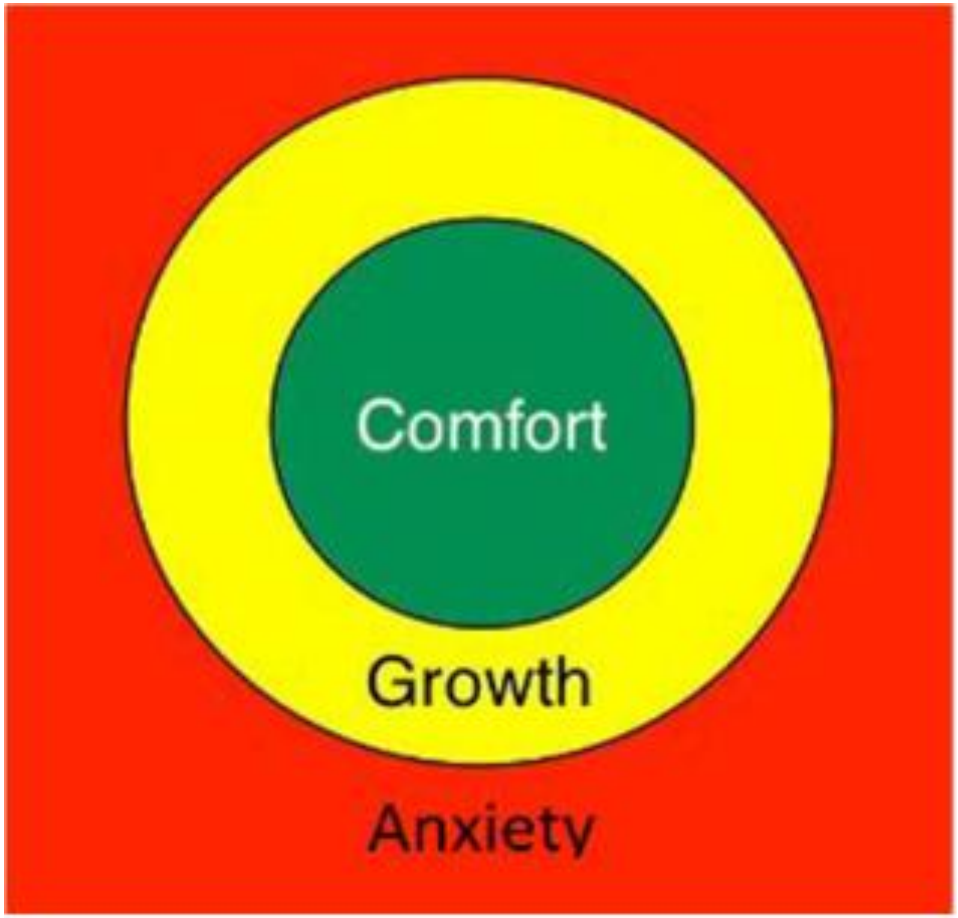


Figure 1: The Growth Zone Model

Resilience Authors

Johnston-Wilder & Lee (2010): "Mathematical Resilience" – mostly connected with perseverance, or "stickability";

Mason et al (1985) link this with "being stuck" as part of mathematical thinking.

Claxton says resilience (one of his 4 Rs of "Learning Power") has 4 attributes: absorption, managing distraction, noticing and perseverance;