

Sheffield Hallam University Department of Engineering and Mathematics **Mathematics** 

## An introduction to Maths and Statistics anxiety

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Resources and previous work

https://maths.shu.ac.uk/mathshelp/Anxious.html

### My maths/stats anxiety journey

### Sheffield University MASH 2011 – 2017

- Research maths anxiety /strategies
- Maths anxiety survey of students
- Awareness workshop/resources
- Several publications and award!

#### Sheffield Hallam University 2017 – date

- PhD: strategies to reduce statistics anxiety (started 2018)
  - Literature review on background, correlates with statistics anxiety, learning behaviour and performance
  - Surveys of 1<sup>st</sup> & 2<sup>nd</sup> year students.

#### **Projects relating to maths/stats support**

- Collaborating with Anna Riach (York) and Amanda Shaker (La Trobe, Melbourne)
  - Original maths anxiety workshop was lacking on strategies
- Updating workshop/resources to improve strategies and stats anxiety component
  - Evaluating effectiveness of maths/stats support

### Maths and statistics anxiety

- Maths and statistics anxiety are situation specific anxieties
- Maths anxiety can be described as "an emotion that blocks a person's reasoning ability when confronted with a mathematical situation" Spicer (2004).
- "Statistics anxiety (SA) is the specific feelings of anxiety students experience when they encounter statistics, for example, gathering, processing, and interpreting data." (Cruise et al., 1985)



### Prevalence of maths /stats anxiety?



85% of students at least mild math anxiety (Perry, 2004)

26% had moderate to high maths anxiety (Jones, 2001)

Statistics is the most fear inducing course (Ziedner, 1991)
80% of students have some stats anxiety (Onwuegbuzie, 2003)

### Mel describes her first Uni maths lesson

- "Well what can I say, after loosing [sic] sleep, worrying about maths my fear was true. I arrived this morning with complete brain block and anxiety. Nervous, scared and petrified of the maths lesson, even though I had read the class notes."
- "Once the teacher started talking my mind went blank as if she was talking a different language, everything she said went in one ear and out the other..."
- "As she asked us to practise questions my mind went on shut down, I started sweating thinking o [sic] my god what if she asks me?"

Activity 1: Discuss how maths anxiety is affecting Mel emotionally, physically and cognitively (what are her thoughts?). Do you see students who are maths or stats anxious and what are the signs that they are maths/stats anxious

## Some physical anxiety responses

- Dizziness
- Muscle tension or pain
- Restlessness
- Sleeplessness
- Difficulty concentrating
- Racing heartbeat
- Fast breathing
- Shaking or trembling
- Stomach ache
- Diarrhoea
- Loss of energy

- Sweating
- Cold, clammy hands
- Chest pain
- Dry mouth

Well what can I say, after loosing [sic] sleep, worrying about maths my fear was true.

 I started sweating thinking o [sic] my god what if she asks me?"

# Some emotional and cognitive anxiety responses

- Feelings of unreality
- Panic
- Being hyped up
- Fear
- Stress
- Recurrent or obsessive thoughts
- Feelings of doom

- Confusion, or inability to concentrate
- "I can't do it"
- "I'm terrible at statistics"
- "I'll never pass"

 I arrived this morning with complete brain block and anxiety. Nervous, scared and petrified of the maths lesson, even though I had read the class notes."

### Behaviour

- Anxiety: Generally anxious and unable to take anything in especially near exams
- **Panic**: Feeling of helplessness that will not go away
- Paranoia: Believing that they are the only person not capable of doing maths/stats
- Passive Behaviour: Feeling there's no point in trying / wanting to quit and go home
- Lack of Confidence: Don't know where to start / expect to never know the answer to questions

### Neuroscience of Maths Anxiety

- Research (2012-2015) using brain scanners (fMRI) have shown that maths anxiety has measurable effects on brain function.
- Using brain images makes psychological arguments more persuasive (McCabe & Castel, 2008).
- Gives students an explanation for their negative feelings and legitimises maths anxiety
- Being self-aware of one's maths anxiety, and the effect that it has on the brain and learning can assist in its reduction. Uusimaki & Kidman (2004),

### "I just can't think about maths"

- Maths anxiety eats away at your working memory because the brain is too busy worrying about maths rather than doing maths.
- This makes maths seem harder than it really is.
- (Young et al., 2012)



### "I can't get started" / "I just can't switch onto maths"

- Like an engine, the brain has an 'idling state' when it isn't focusing on a task. This turns off when you focus on doing something.
- Maths anxiety prevents this 'idling' state from switching off, making it hard to focus on maths.
- Students may feel like they "don't know where to start" to solve a problem.
- (Pletzer et al., 2015)



## "Maths hurts my brain"

- Thinking about maths actually activates the regions of the brain associated with pain.
   BUT
- Actually doing mathematics does NOT activate these pain regions.
- (Lyons & Beilock, 2012)

Given what happens to the brain, how will this affect the behaviour of an anxious student in a mathematical situation?

Medial cingulate cortex



Participants were told there was a maths question coming up

### Maths/Stats Avoidance

Brain sees statistics as a threat, so activates 'fight or flight'.



### Eyes see stats

### Brain thinks "tiger!"



Key behavioural consequence is avoidance leading to:

Opting out of maths/stats Poor attendance and last minute studying Poor performance

### Avoidance

43% of University of Sheffield students surveyed said a fear or dislike of maths/stats had affected at least one of these choices.



Statistics anxiety has been linked to poor performance

Generally due to effort, persistence, and help seeking behaviour though!



## Activity 2

•

- What contributes to someone having high levels of maths anxiety?
- What do you think the differences are between maths/stats anxiety
- Can maths students experience maths and/or stats anxiety?
- Which aspects of statistics do you think students are most anxious about?

### What leads to maths anxiety?

- 93% of students have had a stressful experience with maths (Jackson and Leffingwell, 1999)
- Previous maths experiences including
  - Insensitive/uncaring teachers
  - Told "maths is easy/difficult" when struggling
  - Overly traditional 'Victorian' teaching methods
  - Parental maths anxiety / no help offered
  - Embarrassment and humiliation

**Discussion**: How strong do you think the relationship between maths/stats anxiety is and do you think this will change when studying statistics?

What else may affect statistics anxiety?

### Maths and stats anxiety

- •Maths anxiety is a moderate predictor of stats anxiety
- •Students initially associate stats with maths (Paechter et al 2017)
- Relationship is weaker for:
  those who have studied before
  2<sup>nd</sup> years
- Students with higher maths qualifications can become more stats anxious!



Results from survey of maths and Psychology students 2019 (unpublished)

### Correlates with stats anxiety

• Many factors were strongly statistics anxiety



Survey results for 1<sup>st</sup> and 2<sup>nd</sup> year Maths/Psychology students.

### **Statistics anxiety**

Statistics is different because it requires verbal reasoning.



## Addressing anxiety through statistics support

Ellen Marshall (Sheffield Hallam University) Anna Riach (University of York) Jessica Scott (Sheffield Hallam University)

### Overview

- Strategies for addressing maths/stats anxiety
- Case study
- Are anxious students using stats support?
- Evaluating the impact of individual support
- Evaluating the impact of workshops

### Benefits of one-to-one support

- Quiet, relaxed, supported study area and encouragement of peer learning (Patel & Little, 2006)
- Tailoring to the individual, allowing enough time for inquiry and conceptual development (Woodard, 2004)
- Immediate feedback reduces the negative impact of maths anxiety (Núñez-Peña et al., 2015)

**Mel's story:** "I then went up to 301 where Ellen and Alex discussed my maths, and gave me the support I needed. After calming down and relaxing with Alex I could understand how to do what was asked of me in 35 years I have never been able to do maths, yet once calm I sat there and was able to. My pulse rate slowed down my brain absorbed the maths questions and how to do it."

### Strategies

In order to develop statistical resilience and progress with the learning statistics, several stages are required (adapted from Johnston-Wilder, 2015):

- 1. AWARENESS: Understanding the impact of statistics anxiety and recognising when it is inhibiting learning
- 2. CHALLENGING UNHELPFUL BELIEFS: Belief that everyone can progress with statistical learning (growth mindset) and understanding of the personal relevance of statistics
- **3**. EFFECTIVE STUDY: Understanding of how to study statistics effectively including help seeking

### Jessica's journey

- Jessica came in for help with her dissertation data
- She had some research questions but the data needed recoding

"At the first session I was extremely anxious and overwhelmed by the amount of numbers and things I didn't understand in the software."

 Signs a student is very anxious: Looking visibly nervous/anxious, not taking anything in, wanting to leave, overwhelmed

**Quick discussion:** If a student appears visibly anxious and is not taking anything in, what would you do/say in their first session?

### Awareness and anxiety

- Students who are very anxious will not be able to study effectively (red zone) or understand what is being said
- Comfort Growth Anxiety
- Reassurance and distraction: Reassure the student that is it normal to feel overwhelmed when starting to analyse their own data
- Awareness: Acknowledge it's anxiety stopping them learning
- **Planning**: Discuss a plan for progressing over several sessions

### Challenge beliefs and thoughts

- Reassurance that it's anxiety impacting on learning.
   Resources on how maths/stats anxiety affects the brain
- Discussion of what she was comfortable with and reminding her of the progress she had already made
- Encouragement to write about her weekly progress to reflect on when she became anxious

## Studying statistics

- **Statistical resilience**: the learner develops confidence, persistence and perseverance in the growth zone
- Addressing anxiety: Distraction techniques or other methods for reducing anxiety
- Scaffolding: Develop a sensible, achievable plan allowing time to build up knowledge slowly
- Achievement: Recognise when new learning has happened
- Perseverance: Accept that they may struggle or make mistakes and ask for help when needed
- **Relevance:** Encourage students to recognise where stats is used within their discipline or in daily life



### **Evaluating effectiveness**

- We have all observed the benefits of 1:1 support
- But how can we evaluate effectiveness?
- Most effective method for overcoming maths anxiety but an estimated 33% of 'at-risk' students do not use maths support centres (MSC's) (O'Sullivan et al., 2014)

### **Quick discussion:**

Are anxious students avoiding maths/stats support? Have you evaluated the effectiveness of maths/stats support?

### Impact of stats Workshops on Anxiety

- 14 autumn term workshops at York
- (numerical reasoning, 4 SPSS, 2 R, n = 190)
- "I feel anxious about studying statistics"



### Original maths anxiety workshop (2015)

Embedded within the curriculum (1<sup>st</sup> maths lesson)

40% of 57 classified as moderate to very high maths anxiety

78% of those felt less anxious after the workshop and 59% felt more confident



When the same workshop was run as a general workshop, low attendance and not necessarily target audience

Marshall, E.M., Wilson, D.A., and Mann, V.E. (2017). Evaluating the effectiveness of maths anxiety awareness workshops..

## Updated Anxiety Workshop

Updated original maths anxiety workshop to include more on stats anxiety and more specific strategies

- Trialled as part of Maths and Stats Week (York)
- Title and blurb tried to sell it
- 12 sign ups for session great!
- Only 6 showed up not so great
- Students filled discussion points

Wednesday 12 February

# 11am: How to learn statistics when you don't want to How to learn statistics when you don't want to Ellen Marshall, Sheffield Hallam University Wednesday 12 February 11am-1pm SLB/211 If you have to learn or use statistics in your studies but are not fond of the subject, then this session is for you.

Ellen Marshall teaches statistics at Sheffield Hallam University and researches Maths and Statistics anxiety. She will explain these types of anxiety and the effects they have on learning statistics. Please come along and explore those negative feelings some people have towards statistics and be assured you will NOT be asked to do any statistics! If you are a statistics lecturer you may also find this session useful.

### **Quotes from Anxiety Workshop**

### Reflecting on past experiences

"Maths test and examination in high school"

"Others knowing far more than me in terms of statistical analyses"

"Did not get MEng"

"Getting upset/tearful/anxious/fustrated in class makes it harder to go back & to ask Qs."

• What will you remember

"Jessica's story"

"Resources to use"

"Start small with manageable tasks"

"Try to manage anxiety in lecture"

Other comments

"People really opened up – felt like therapy!"

### Final discussion

- Do optional anxiety workshops just cater for those willing to do something about their anxiety anyway?
- Are workshops or 1:1s more effective at addressing anxiety?
- How can we encourage anxious students to use maths/stats support?

## Publications (Ellen)

- Anxiety resources and publications avaiable on Sheffield Hallam: <u>https://maths.shu.ac.uk/mathshelp/Anxious.html</u>
- Johnston-Wilder, S. and Marshall, E.M. Overcoming affective barriers to mathematical learning in practice. IMA and CETL-MSOR 2017: Mathematics Education beyond 16: Pathways and Transitions
- <u>Marshall, E.M., Staddon, R.V., Wilson, D.A., and Mann, V.E. (2017).</u> Addressing maths anxiety and engaging students with maths within the curriculum. *MSOR connections*.
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  - Paechter, M., Macher, D., Martskvishcili, K., Wimmer, S. and Papousek, I. (2017). Mathematics Anxiety and Statistics Anxiety. Shared but also unshared components and antagonistic contributions to performance in statistics *Frontiers in Psychology*, 8, 1196
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