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The incidence of maths anxiety in applied mathematical subjects at undergraduate level and the impact of mindfulness techniques as a pedagogical strategy

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ABSTRACT

Undergraduate students in engineering and real estate courses require mathematical skills to be successful in a number of modules. It is clear that a significant number of students are experiencing maths anxiety during class activities and this is a barrier to learning and attainment. It is expected that maths anxiety may have a relationship with attendance, attrition and attainment. The core of this paper is exploring which particular maths activities are causing higher levels of anxiety amongst students and if interventions are effective in reducing anxiety. Research by Samuel, Buttet and Warner (2022) has shown simple MAGMA (Mindfulness and Growth Mindset Approach) techniques are effective in reducing this anxiety. MAGMA techniques were introduced at the beginning of each session and at the end of the semester students were asked to reflect on the effectiveness of using MAGMA this semester. In addition, we explore if there is a different pattern emerging between courses, genders or related to previous mathematical attainment.

INTRODUCTION

It has been reported that 35% of UK adults feel anxious when doing maths (KPMG 2023). Maths anxiety has been defined as “*feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations*” (Richardson and Suinn 1972). The incidence of maths anxiety amongst females and minority ethnic groups is high, and Erickan et al, (2005) found that maths anxiety negatively impacts women and ethnic minority groups pursuit of courses and careers in STEM. Yu X et al (2024) in a large study of 28,129 students found that both male and female students experience maths anxiety but the link between anxiety and performance is stronger for females.

There is currently a limited research base of evidence from an applied mathematical context or analysing data from a university students. In a study of a sample of 231 university students

Rozgonuk et al (2020) found there was no significant difference between the incidence of maths anxiety amongst STEM and social sciences students, it also identified self-efficacy was a major factor affecting maths anxiety. In another study, Leppma M and Darrah M (2024) mindfulness, self-efficacy and self-compassion are identified as predictors of maths anxiety. The study of how emotions can present a barrier to our cognitive processes is well documented and the field of compassionate pedagogy is being developed as educators seek to collaborate with students to create an environment that is conducive to learning for all. In this post pandemic age where rates of anxiety have increased and reintegration into society require significantly more social contact and empathy we as educators can equip students with tools to self-regulate, build resilience and allow effective learning to take place.

AIM OF THE STUDY

This study aims to assess the mathematics anxiety and general numeracy ability of two cohorts of students studying Real Estate and Mechanical Engineering using validated instruments via questionnaire. An intervention to develop mindfulness and a growth mindset (MAGMA) will be introduced to students and revisited at the beginning of each class. Perceived effectiveness of MAGMA will be evaluated by the student via online questionnaire at the end of the semester. The research questions are :

- To what extent does maths anxiety exist amongst students in applied maths courses?
- Is there a correlation between maths anxiety and growth mindset in the sample?
- Is there a statistically significant difference in maths anxiety and growth mindset scores between female and male students or by course?
- Has the introduction of MAGMA reduced maths anxiety?

METHODOLOGICAL APPROACH

The study used validated instruments : the Berlin Numeracy scale (a psychometric test) to determine statistical numeracy and risk literacy; the UK Maths Anxiety scale (MAS-UK) and the three item Growth Mindset scale to produce a baseline for the cohort of students. Data were collected using these survey instruments using a Microsoft Form in Week 1 of the semester along with key demographic factors. The MAS-UK poses a series of 23 scenarios or maths activities and students are asked to rate using a 5 point Likert scale.

The MAGMA intervention approach was implemented at the beginning of each session and encouraged as part of directed study. The specific interventions are a set of growth mindset statements displayed at the beginning of each class and practicing a box breathing technique to reduce anxiety. A small card developed with a QR code for box breathing and growth mindset statements to act as an aide memoire was given to students. The resources were also provided on the virtual learning environment.

At end of the semester the UK Maths Anxiety instrument was rerun along with a short questionnaire on the perceived effectiveness of MAGMA interventions over the period of the module delivery. Attendance figures were used as a proxy for level of interest and engagement and compared with other modules in that semester. Attrition and failure rates were also monitored. The sample contained 54 students (76% male and 24% female).

KEY FINDINGS OR OUTCOMES

The profile of respondents shows representation across engineering and real estate courses and by ethnicity and previous mathematical attainment.

In analysing the mathematical activities contained in the maths anxiety instrument it is evident that the same activities are considered high anxiety activities by all students. These activities include 'Being asked to write an answer on the board at the front of a maths class'; 'Being given a surprise maths test in a class' and 'Being asked a maths question by a teacher in front of a class'.

Female students report higher levels of anxiety than male students in 91% of activities. Surprisingly the students who have the highest mathematical attainment before joining the course, Mechanical Engineering MEng students, also experience the highest levels of anxiety compared to the other 2 courses in 55% of the scenarios.

Following MAGMA intervention 74% participants had used the breathing techniques and 60% stated they had used techniques outside the classroom. 19% students reported that box breathing had reduced maths anxiety and a further 44% said 'maybe' breathing was reducing their maths anxiety.

DISCUSSION

There is evidence that maths anxiety is an issue for student across all courses and applying mathematical knowledge is an integral part of successful completion. This pilot indicates that intervention can alleviate some maths anxiety. This study supports the findings that emotional as cognitive factors are important considerations when considering attendance and attainment. It also highlights that common activities such as selecting students in class to demonstrate or calculate requires a sensitive and supportive approach acknowledging that these are potential high anxiety activities for some students. In developing a growth mindset in class and encouraging student self-compassion it is expected that students will develop resilience as learners.

Some of the limitations acknowledged by the authors is the small sample size which is a pilot. Students self-selected but the sample is representative of courses, genders and ethnicities of the cohorts. Students also reported the full range in levels of maths anxiety (1-5). All students that participated used the MAGMA techniques so there is no control group it was considered unethical and logistically difficult to exclude students from using MAGMA.

Commented [BA1]: Is there a simple statistic that confirms that it helps? It isnt in the key findings.

CONCLUSIONS & RECOMMENDATIONS

The recommendation is that small changes in how we teach rather than what we teach can encourage more mindfulness and a growth mindset amongst our students, and reduce maths anxiety. Reducing anxiety will increase working memory and allow students to access the material and content which is presented in class. This research also offers an effective intervention that will increase accessibility for female students which is an important EDI consideration. A further study could focus on the impact of teacher related factors in identifying and reducing maths anxiety as this research focuses on the student experience.

REFERENCES

- Cokely, E., Galesic, M., Schulz, E., Ghazal, S., & Garcia-Retamero, R. (2012). Measuring Risk Literacy: The Berlin Numeracy Test. *Judgment and Decision Making*, 7(1), 25-47.
doi:10.1017/S1930297500001819 (Seminal paper on Berlin Test)
- Dweck, C (1999) *Self-theories: their role in motivation, personality, and development*. Philadelphia: Psychology Press
- Hunt T, Clark-Carter D and Sheffield D (2011) 'The Development and Part Validation of a U.K. Scale for Mathematics Anxiety' *Journal of Psychoeducational Assessment* 29(5) 455–466 (UK-MAS Scale)
- Leppma, M and Darrah M (2024) 'Self efficacy, mindfulness and self compassion as predictors of maths anxiety in undergraduate students' *International Journal of Mathematical Education in Science and Technology*, 55:4.
- Mier H et al (2019) 'Gender differences regarding the impact of math anxiety on arithmetic performance in second and fourth graders' *Frontiers in Psychology*, Volume 9.
- Rozgonjuk D et al (2022) 'Mathematics anxiety among STEM and social sciences students : the roles of mathematics self-efficacy, and deep and surface approach to learning.' *International Journal of STEM*, 7:46.
- Sammallahti, E et al (2023) 'A meta-analysis of maths anxiety interventions' *Journal of Numerical Cognition*, Volume 9(2) pp 346-362.
- Tashana S. Samuel, Sebastien Buttet & Jared Warner (2023) "I Can Math, Too!": Reducing Math Anxiety in STEM-Related Courses Using a Combined Mindfulness and Growth Mindset Approach (MAGMA) in the Classroom, *Community College Journal of Research and Practice*, 47:10, 613-626, DOI: 10.1080/10668926.2022.2050843 (rationale for MAGMA)
- Yu X et al (2024) 'Maths anxiety is more closely associated with math performance in female students than in male students' *Current Psychology* 43 pp 1381-1394.
- Zanabazar A et al (2023) 'A study of factors causing math anxiety among undergraduate students' *International Journal of Innovative Research and Scientific Studies*, 6(3), pages: 578-58