CENTRES FOR EXCELLENCE IN MATHS

Brighton MET and Northbrook MET

MET Greater Brighton Metropolitan College

Worthing College

Mindfulness in FE Maths GCSE Resits – an action research report

Paloma Hanlon – GBMET

Paula Wheeler – Worthing College

Acknowledgements

Thanks to Jem Shackleford, Elinor Brown and Niamh Bruce at the Mindfulness in Schools Project for their excellent training and guidance.

About CfEM

Centres for Excellence in Maths (CfEM) is a five-year national improvement programme aimed at delivering sustained improvements in maths outcomes for 16–19-year-olds, up to Level 2, in post-16 settings.

Funded by the Department for Education and delivered by the Education and Training Foundation, the programme is exploring what works for teachers and students, embedding related CPD and good practice, and building networks of maths professionals in colleges.

Summary

The aim of this action research project was to investigate how our cohort of students would respond to mindfulness interventions and to discover whether mindfulness could have a positive impact on maths anxiety. In the first year of the project, teachers were trained to develop their own mindfulness practice and then to deliver a 4-session course to students which covered mindfulness practice, physiological responses to stress and aspects of meta-cognition. This programme was rolled out in the second year of the project, with some delays and disruption due to the Covid 19 pandemic. Data was collected before the intervention and after the intervention to measure levels of maths efficacy and reported levels of maths anxiety. Data collection methods included quizzes, questionnaires and interviews. Two teachers in two colleges delivered the mindfulness programme to selected groups of students. A total of 38 students had access to the mindfulness training and resources. A total of 16 students responded to the data collection surveys.

Overall, student response to the mindfulness intervention was positive. The majority of students could see how mindfulness could benefit them in their daily lives and most were positive or neutral about using class time to deliver mindfulness sessions. The mean level of reported evaluation anxiety decreased after the mindfulness intervention. Students valued the mindfulness practices they did in class and the resources that supported home practice. The scale of this research was quite small, but the findings suggest that mindfulness training, when delivered by experienced teachers who are confident in their own practice, is valued by students and can reduce maths evaluation anxiety in class and in assessments.

Contents

Background

Introduction

Greater Brighton Metropolitan College is a further education college in the South-East of England offering vocational qualifications and access-to-university courses across five different sites in Brighton and Worthing. We are a CfEM centre of excellence and have conducted action research and CPD programmes for the last 3 years with the aim of improving teaching and learning in our college and in our network colleges.

Outcomes for learners have improved consistently over the last 3 years, with GCSE higher pass rates of 4 or above at 36% for the 2020-2021 academic year. Learners receive two face-to-face maths lessons a week (2 x 1.25hours) supported by 1 hour of self-directed study. In cross-college student surveys learners reported positive views on the Maths provision, with 98% of students saying the resources were good and 86% reporting the quality of teaching and learning was good. Despite positive experiences in the classroom (and online) attendance in Maths is consistently below the college's target of 95%.

Our learners

There are around 1200 learners in the 16-19 age group enrolled onto GCSE maths at GBMet. Students are based across all five sites. During the Covid 19 pandemic learners studied face-to-face for the first term, attended live online classes during the lockdown in the second term and returned to face-to-face classes in the third term.

There is a high level of SEN among our resit learners and declared mental health issues. Teachers report high levels of maths anxiety, test anxiety and general anxiety in their classes – the latter having been exacerbated by the pandemic and the isolation of lockdown.

One key aim of the college is to improve attendance and engagement in maths so that learners have the best chance of success. To that end, we are looking for ways of reducing the anxiety learners feel about being in class and resitting their exams. Although the mindfulness action research was first conceived before the pandemic, the intervention became increasingly relevant in the context of the Covid 19 crisis.

Why Mindfulness?

As a response to high levels of learner anxiety, we were looking for an intervention that could support learners to engage in class, attend consistently well and perform as well in assessments as they do in class. Mindfulness seemed a good fit. Mindfulness can be defined as a set of meditative practices to help us be more present in our daily lives. These practices can be guided by another person, a recording or can be self-guided. Mindfulness focuses on the breath and body as a jumping off point to explore sensations, emotions, thoughts and impulses that are happening in the here and now. Mindfulness is promoted as a way of accepting our experiences and making thoughtful choices about how to respond to them.

Our research aim was to investigate how our cohort of students would respond to mindfulness interventions and to discover whether mindfulness could have a positive impact on maths anxiety.

In the first year of the action research programme the literature review brought up salient points that steered the project towards a sub-focus on how teachers responded to mindfulness training. Reports from schools who had trialled mindfulness described a mixed response from students depending on the level of commitment from staff, especially from leadership teams. (Wilde et al, 2019) A principle emerged from the first literature review that

the effectiveness of mindfulness provision relied on teachers being properly trained in mindfulness and confident in their own practice. (Weare and Huppert, 2019) It was also found that the effectiveness of mindfulness interventions in schools relied on high quality teaching from those delivering it. The trainers from the Mindfulness in Schools Programme confirmed that in their experience a highly competent teacher who was relatively new to mindfulness was preferable to an experienced mindfulness practitioner who was new to teaching. These findings shaped the action research training programme in the first year.

Literature Review

In the second year of the programme the focus shifted back to how the students would respond to mindfulness training and how to measure that response. The literature that informed that focus dealt with the effect of mindfulness on learning in general, the impact of maths anxiety on engagement and mathematical thinking, the potential effects of mindfulness on maths anxiety and how best to measure these.

Established Benefits of Mindfulness

There is much research that suggests mindfulness is **beneficial to the well-being of young people as a whole**, which could improve their ability to access learning (Ager, 2015) Some research that suggests that it **can help students academically** - to focus for longer and regulate their behaviour (Janz, 2019 and Weare and Huppert, 2019) There is little research into the impact of mindfulness on maths attainment in particular but there is one 2019 study with community college students in the US taking Statistics that showed how a programme of mindfulness combined with growth mindset instruction resulted in a **reduction in maths anxiety** and an **increase in maths self-efficacy**. (Samuel, 2019) A small-scale action research project in a secondary school in London also trialled mindfulness interventions with students and found, “As a consequence of this project, student's attitude has either remained unchanged or has shown a positive shift towards learning Maths and Statistics” (Chikvaidze)

Mindfulness vs Maths Anxiety and Stereotype Threat

One key supposition of our action research is that mindfulness would have an effect on the maths anxiety that students experienced. Maths anxiety is linked to poor mathematical performance, negative attitudes towards maths and avoidance of the subject. (Hembree, 1990) Studies have found that maths anxiety is higher in females than in males (Hembree, 1990) and there is intersectionality between maths anxiety and stereotype threat, where individuals who are the target of a negative social stereotype feel heightened anxiety about the need to disprove the stereotype. (John Buck, 2019) Certain aspects of mindfulness practice seem well suited to help with these negative effects. The development of metacognition - where students are encouraged to accept thoughts as just thoughts that can come and go - could help to counter the additional affective and cognitive stress of stereotype threat, for example. One study by researchers in the UK, Cyprus and the US found that, “performance decrements that typically occur under stereotype threat can indeed be reversed when the individual engages in a brief (5 min) mindfulness task.” (Weger et al, 2012) Practices that are designed to work on the flight, fight and freeze response could also help students to understand why their anxiety leads to avoidance and provide tools to allow them to counter it.

MRI research - which was anticipated by Mark Ashcraft nearly 20 years ago when he was considering the future of maths anxiety research (Ashcraft, 2002) - has found there is a better response in the brain when you target the very early effects of maths anxiety (through reappraisal of a task for example) than when you try to suppress the emotional responses during performance (Lyons and Beilock, 2012). If we consider these findings in relation to mindfulness, students who learn how to recognise the early signs of anxiety and reframe their experience through a short mindfulness practice could avoid the “performance decrements” that arise from maths anxiety. Of course, we don’t have access to an MRI machine or students willing to climb into one in the name of action research, so we needed to consider how we could measure the effects of mindfulness on maths anxiety.

Established Measures of Maths Anxiety

Richardson and Suinn defined maths anxiety fifty years ago 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) They designed their Maths Anxiety Rating Scale to measure anxiety across a range of contexts and it was widely used in research for many decades. However, the terminology used in the questionnaire was North American centric and somewhat dated so in 2011 researchers at the University of Derby developed and tested an adapted version, the MAS-UK which they claim “may represent an easily administrable, reliable and valid tool for assessing maths anxiety in British and potentially European undergraduate student populations.” (Hunt, T. E. et al, 2011) For our action research we further adapted the MAS-UK maths anxiety scale so that it was shorter (12 questions as opposed to 23) with slight changes in the questions to make them easier to read so that it suited our further education cohort, rather than the undergraduate population for which it was developed.

The literature suggests that mindfulness has potential to not only improve outcomes for students in a holistic sense, related to their overall wellbeing, but may specifically work on established affective processes linked to maths anxiety, reducing their impact on cognition and allowing learners to engage more fully and experience more success in Maths. Our primary research aim, then, is to investigate how learners respond to a short course on mindfulness measuring any changes in maths efficacy and in learners’ reported levels of maths anxiety.

Methods

Training teachers to deliver mindfulness

8 teachers participated in an initial one-day training course, *Train to teach* .breathe, run by the Mindfulness in Schools Project. Although the course is designed so that educators with little to no experience of mindfulness would be equipped to deliver the 4-session *.breathe* programme, the findings from the literature review and feedback from the teachers themselves indicated that further training in mindfulness and the time to develop their own practice were required to deliver the programme with confidence. 5 teachers (4 of the original 8 and 1 new recruit) took a further 8-week course of mindfulness study, called *.begin*. A top-up workshop was then offered to prepare these teachers to teach the *.breathe* programme to students. The covid crisis and nation-wide lockdowns occurred during this training programme. Staff changes and personal circumstances led to many of the trained teachers leaving the project. These changes combined with lockdown and the increased workload in adapting to online teaching delayed the roll-out of the mindfulness sessions with students. Two new teachers were recruited and trained to teach *.breathe* in the final months of the project, with one of the new recruits experiencing the same lack of confidence that the initial group of teachers had felt after the one-day training course. In the end 2 teachers delivered mindfulness sessions to their students.

The mindfulness programme we chose

The *.breathe* programme is four 45-minute sessions, developed by the Mindfulness in Schools Project, that are a combination of PowerPoint slides, animations, teacher-guided discussions and sound files that are guided meditations. The four themes of the sessions are Training the Mind, Working with Worry, Sleep, and Connection to Others. There are also a set of home practices (animations, worksheets and guided mediations) that were made available to students on the Google classroom for them to use at home.

Delivery at GBMET

One teacher in GBMET delivered the four sessions over 5 weeks to two classes. One class was composed of students from a mixture of vocational courses and included a mix of genders. The other class was composed of all motor-vehicle students and was predominantly male, with just one female student in the class. Students' cameras were off during the sessions but they were encouraged to use their microphones to engage in discussion and use the chat function. Many of the students in the classes missed one or more of the sessions and some students could not access the classes at all due to lack of internet access (these students were completing maths work that was posted to them but could not engage in the mindfulness sessions). A total of 16 GBMET students attended at least one of the mindfulness sessions. The sessions were completed in the final weeks of the January/February lockdown of 2021 and upon their return to face-to-face teaching GBMET students sat a series of in-class assessments under exam conditions to contribute evidence to their teacher-assessed grades.

Delivery at Worthing College

One teacher from Worthing College delivered the sessions face-to-face to students who volunteered to attend during lunchtimes. There also was not consistency in the attendance of these sessions. The sessions occurred within the 3 weeks after the bulk of GCSE Maths assessments had finished but while students were taking other exams for A-levels. The fact that participation in the provision was optional and the timing of the intervention had an impact on the uptake from students.

Data collection – mental maths tests and questionnaires

The teachers conducted two rounds of data collection using Google forms - one before the students had attended any mindfulness sessions and one round afterwards. Students were encouraged to complete a short mental maths test (Appendix 1) to get a baseline of their maths efficacy and to complete the Maths Anxiety Scale questionnaire. (Appendix 2) The questionnaire is designed to measure three different types of Maths anxiety: maths evaluation anxiety (tests, quizzes, being put on the spot); everyday/social maths anxiety (making change, working with time); and maths observation anxiety (being in a classroom, passive watching/listening). Three questions were included to measure if students are noticing a cognitive effect related to ability to focus ("my mind goes blank") and/or accompanying physiological and affective responses ("I feel tense" or "I get a sinking feeling").

After attending the mindfulness sessions students were asked to complete another mental maths test (which had very similar questions to the first test but with different numbers used) and a second MAS questionnaire. The second questionnaire had an additional section designed to capture the students' experience of the mindfulness sessions.

Interviews

Students who showed a high level of maths anxiety in the first questionnaire were asked to participate in a 10min interview. One student in the GBMET cohort agreed, the interview was conducted after she participated in mindfulness sessions, and her experiences were used as a case study.

Research aims

The over-arching question we are hoping to answer with this research is: How do post-16 GCSE maths students respond to mindfulness interventions? Our research aims are:

- To discover whether mindfulness positively impacts on maths stress/anxiety.
- To explore whether mindfulness intervention can impact on focus levels within maths.
- To measure any changes in maths efficacy after a short course of mindfulness
- To identify those students who are engaging with mindfulness and those who are not and to explore reasons for this

Results and Discussion

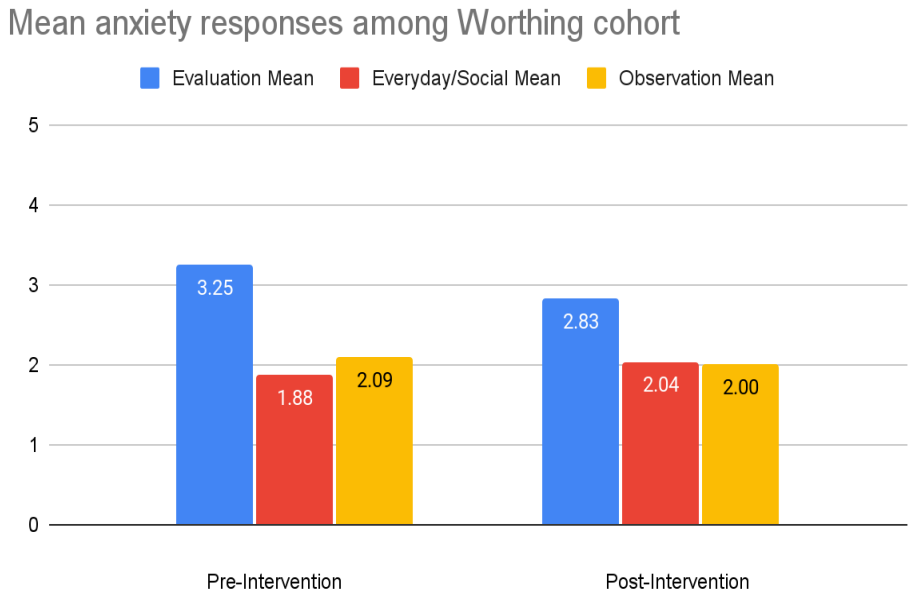
The effect on Maths efficacy

It was a difficult time to get accurate measures of an effect on maths efficacy. The Covid pandemic produced two assessment periods where the assessment methods were significantly different from the previous years and from each other. This means that comparing a student's grade after the mindfulness intervention with their previous performance was not valid. The short mental maths test was included to provide some controlled measure of maths efficacy; however the results were not helpful in marking any real change. Most students scored well on the first test, with a median score of 9/10 so there was little room to improve after the intervention. Further, the GB MET cohort completed the test online at home and so there is no way of verifying whether they used calculators. It became clear after the first round of data collection that the main findings of the research would be drawn from the students' responses to the Maths Anxiety Questionnaires and interviews, focusing on the students' reported levels of anxiety and their feelings about the intervention's usefulness.

The effects on reported anxiety

Students' responses were totalled, and a mean score was calculated for each type of anxiety before the intervention and then compared with their responses after the intervention. (Fig. 1)

Fig. 1

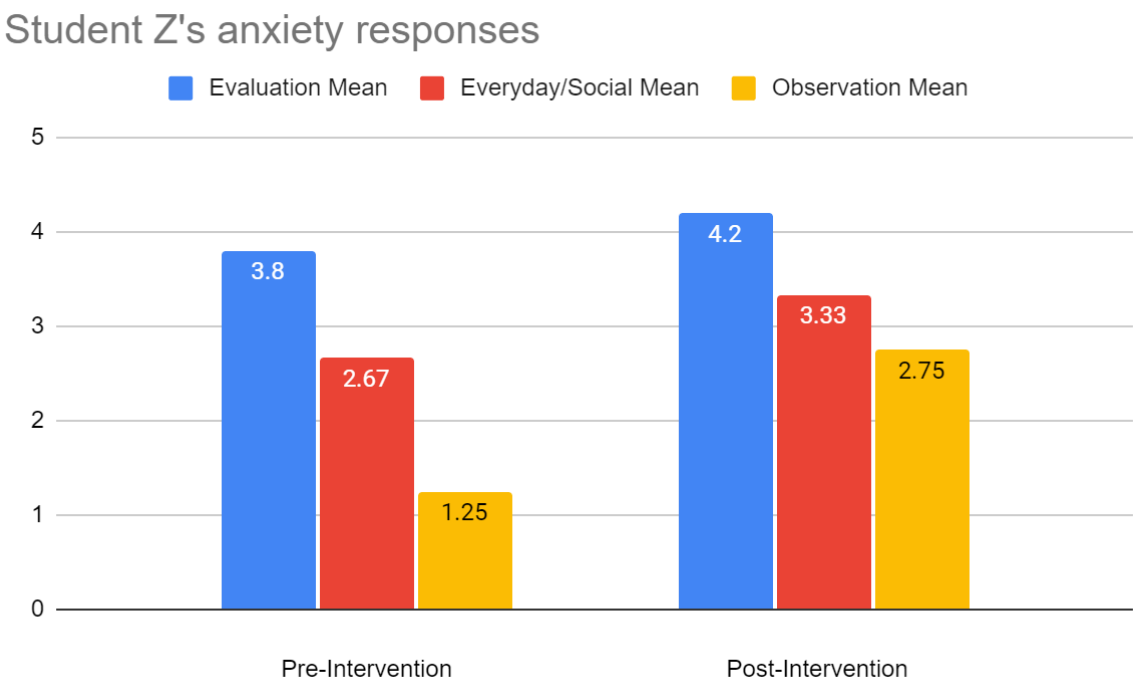


Evaluation anxiety dropped the most from 3.25 to 2.83. The individual scenario with the biggest drop was "Being given a surprise maths test in a class", which dropped from 3.9 to 2.9 - from 'much' to 'a fair amount'. The second biggest drop was "Being asked a maths question by a teacher in front of a class." which moved from 4 to 3.25. Everyday/Social anxiety was the lowest mean score before the intervention and it increased a small amount from 1.88 to 2.04, still hovering around "slightly" anxious. The individual scenario with the biggest increase was "Adding up a pile of change." which moved from 1.5 to 1.88. The

increase of everyday/social anxiety is not due to one outlier, but rather occurred for many of the respondents.

It is important to note that the effect on individual students could vary quite significantly from the mean effect on the group. Student Z is a fascinating example of this. In the first questionnaire, this student responded to the optional question, “Do you have any other comments about your experiences of maths?” with the statement, “I do not like being put on the spot, my mind goes blank, I panic and get embarrassed.” Student Z attended all four sessions and reported trying the home practices at least once. This would be the type of student we would hope would benefit the most from a mindfulness intervention. However, their post-intervention questionnaire showed an increase in reported anxiety in all three categories. (Fig. 2)

Fig. 2



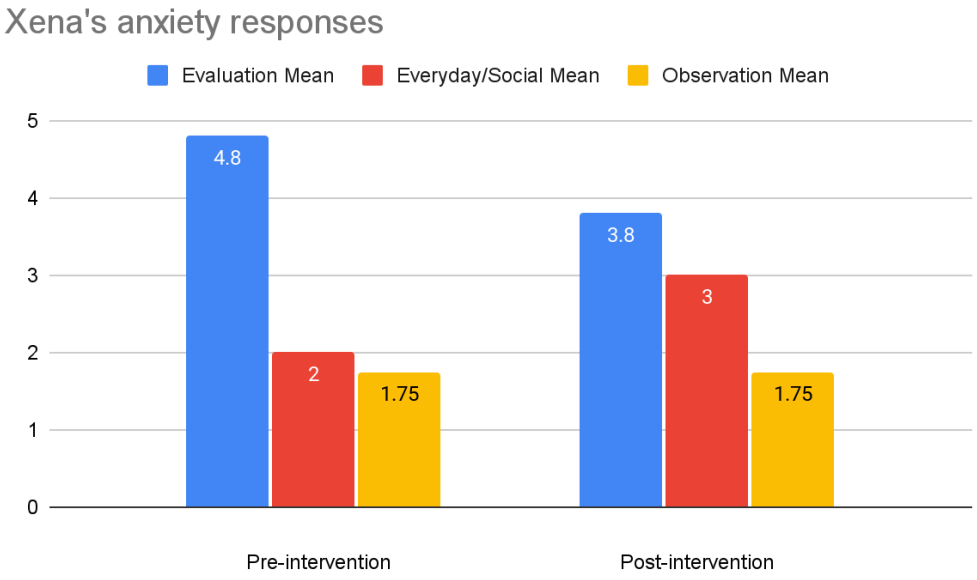
Along with the surprising rise in reported everyday/social anxiety within the whole cohort, this individual’s results introduce the possibility of an unwanted increase in maths anxiety among the participants. It is difficult to tease out the possible contributing factors to this increase in everyday/social maths anxiety. It could be that the general levels of anxiety, including generalised social anxiety, were heightened during the Covid pandemic and lockdowns, leading to students feeling more anxious about scenarios presented in social contexts. It could also be that the very nature of mindfulness gave rise to this phenomenon. In tuning in to their thoughts about and emotional responses to maths, some students might be experiencing an increased awareness of their anxiety and thus reporting higher levels of anxiety on the second questionnaire. This does not necessarily mean they are experiencing heightened affective or cognitive effects of their anxiety. In fact, Student Z’s agreement response to the statement "I get really tense while taking maths tests." shifted from “Always agree” before the intervention to “Sometimes agree” after. The aim of mindfulness practice is

not to eliminate feelings of anxiety altogether, but rather to accept them as normal and natural and to develop the ability to rebalance the body and refocus the mind even when feeling anxious. A longer intervention, where students develop their mindfulness practice more fully, combined with a more nuanced investigation of reported anxiety and long-term mindset about maths might shed some light on this effect.

Case Study - Xena

The student experience of mindfulness can be further illuminated by a case study of one GBMET student. At the time of the study 'Xena' was enrolled on Level 2 Beauty Therapy and worked part-time in a pub in addition to working in a salon for her placement. This is Xena's 3rd year of sitting GCSE Maths - one year with traditional exams, one year of centre-awarded grades and this year her results will be determined by teacher-assessed grades. One of her grandparents, to whom she is very close, was ill and in hospital during the assessment period. She often complains of poor sleep, stress, headaches and other minor health problems. She gets on well with the rest of the group, is polite and follows instructions but often expresses a desire to be doing anything other than maths. Xena has no prior experience of mindfulness. She had been offered mindfulness in the past through a school counselling programme and mentors at college but wasn't interested. Xena attended 2 of the online sessions and reported trying the home practices 3 or 4 times during the intervention period. She did not complete the mental maths test at the start of the intervention because she found it too stressful. She completed it at the end of the intervention, and she completed both questionnaires (pre- and post-intervention).

Fig. 3



Xena's mean evaluation anxiety score of 4.8 is much higher than her scores for the other forms of anxiety and higher than the group mean of the Worthing cohort (which was 3.8). She reports feeling 'very much' anxiety in almost all the evaluation scenarios before the intervention. After the intervention, her mean evaluation anxiety dropped from 4.8 to 3.8 from 'very much' to 'much'. The individual scenarios where Xena reported the biggest drop were "Being given a surprise maths test in a class" and "Taking a maths exam" which both dropped from 5 to 3 - from 'very much' to 'a fair amount'. Xena's agreement with a key

anxiety statement shifted as well. Her response to "I get really tense while taking maths tests." moved from ‘always agree’ to ‘uncertain’ (neutral position). This suggests that the mindfulness reduced her level of evaluation anxiety.

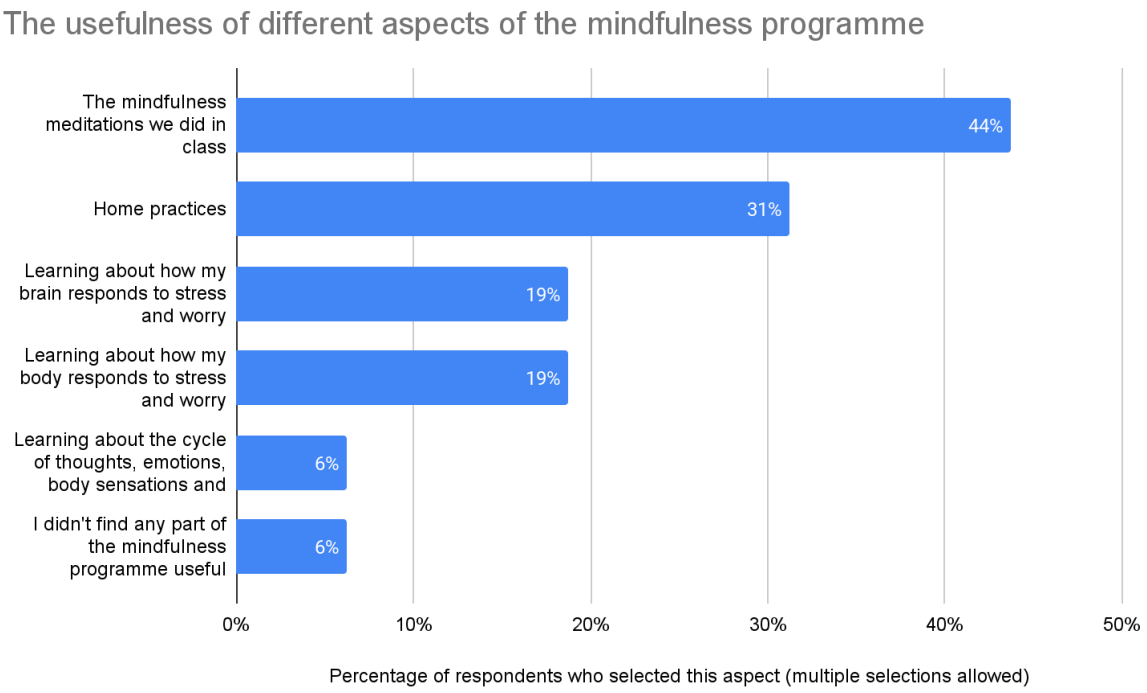
Xena agreed to a post-intervention interview to further explore the effects she experienced due to the mindfulness intervention. In the interview Xena revealed that she fell asleep during the first guided meditation, (which was not the session that is specifically about sleep) and reported sleeping well the night after the session. She said, “It made me really chilled...It took a lot of weight off my shoulders.” In the interview, Xena reported a shift in attitude towards Maths as a result of the mindfulness sessions. “I think I was a lot more laid back with my Maths,” she said. She also reported tackling questions she would normally have left. “I think I came into class with a can-do attitude, occasionally.” Given more reflection time in the interview, she felt that there was one overriding benefit: “Actually I think it’s because I got a lot more sleep... I was ready to learn.”

Despite having positive experiences during the mindfulness intervention, Xena revealed in the interview that she had not done any mindfulness since the sessions that were delivered in class. She felt like she didn’t have the time to fit it into her day. She reported feeling very stressed about the remaining Beauty Therapy assessments she had to complete and her job at the pub. The fact that Xena had passed on opportunities to try mindfulness in the past and was not taking the time to practice it after the structured intervention had ended suggests that she benefited from having the mindfulness practice built into her provision and class time allocated to it. This loss of engagement after the intervention stopped could also indicate that the intervention wasn’t long enough to become habit-forming. Further study into the uptake and continued practice of mindfulness among students would be required to determine whether regular, integrated opportunities to practice mindfulness in class are more or less effective than a robust introduction followed by access to resources for home practice.

Students’ perceptions of the usefulness of mindfulness

The second Maths Anxiety Scale Questionnaire included questions designed to capture students’ opinions on the usefulness of the mindfulness intervention. (see Appendix 3) The responses of the Worthing College and GB MET cohorts are combined in Figure 4.

Figure 4.



The two aspects of the programme that students found most useful were the meditations done in class (44% chose this) and the home practices (31% selected this). Only one respondent said they did not find any part of the mindfulness programme useful. It is a reasonable assumption that some of the students who attended the lessons but chose not to respond to the survey did so because they felt the intervention was not useful, but in the absence of actual data that is speculation.

Students were also asked the extent to which they agreed with statements about the benefits and usefulness of mindfulness in maths class and in their daily lives. The results are shown in Figure 5, Figure 6 and Figure 7.

Just under a third (31.3%) of students felt that mindfulness practices could help them stay calm when doing maths. Most of the group felt neutral about that statement with just one person who strongly disagreed (Fig. 5). The majority of students (56.3%) agreed or strongly agreed that mindfulness could benefit them in their day-to-day life. (Fig. 6) Seven respondents (43.8%) felt that mindfulness sessions were a good use of time in maths class and an equal number of students felt neutral about that statement. (Fig. 7) It seems that there is a proportion of students who, although they are not convinced that mindfulness affects their ability to perform mathematically, can see the holistic benefits of the practice and therefore welcome the use of class time on mindfulness.

Fig. 5


"I feel that mindfulness practices could help me stay calm when doing maths"
6.3%
31.3%
62.5%
Agree
Neutral
Strongly Disagree

Fig. 6

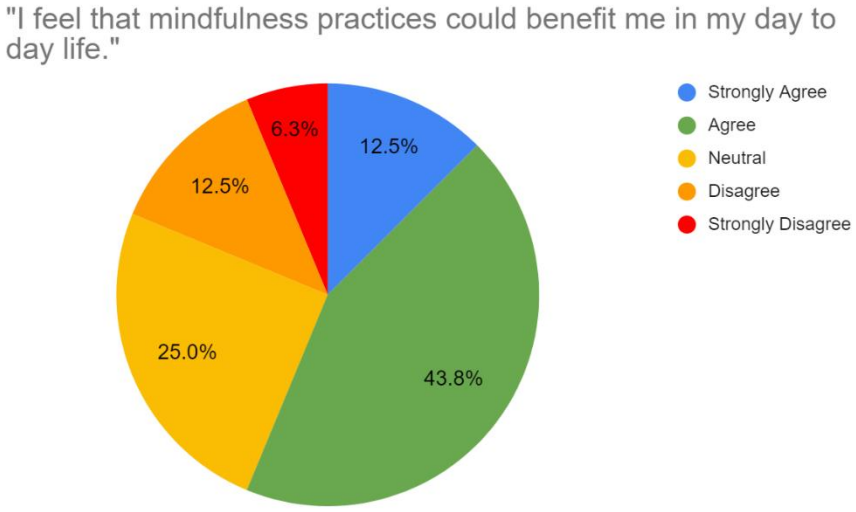
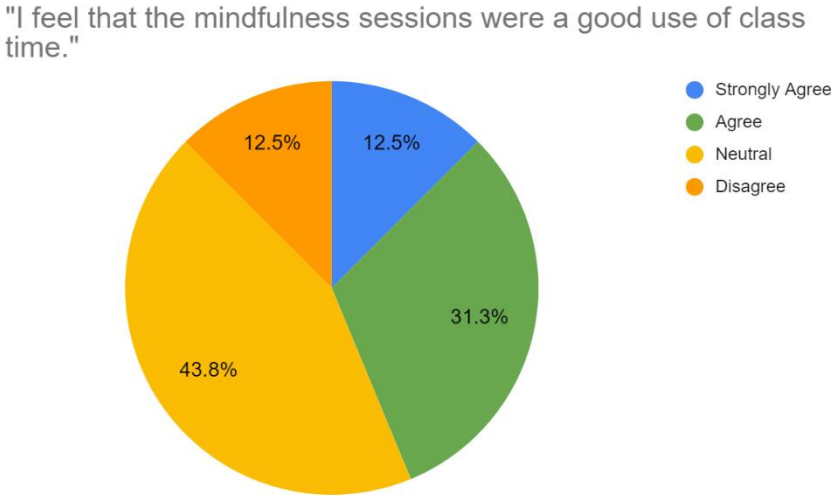

"I feel that mindfulness practices could benefit me in my day to day life."
6.3%
12.5%
12.5%
25.0%
43.8%
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree

Fig.7


"I feel that the mindfulness sessions were a good use of class time."
12.5%
12.5%
31.3%
43.8%
Strongly Agree
Agree
Neutral
Disagree

Conclusions and Recommendations

Conclusions

The student experience of taking a short mindfulness course during their GCSE resit provision was reported to be a mostly positive one. Students could see how mindfulness might benefit them in their day-to-day lives and most agreed that taking the course was a good use of class time.

The mindfulness sessions did seem to have the desired effect on maths anxiety, in that the mean average reported levels of evaluation anxiety were lower after the intervention. Evaluation anxiety was the type of anxiety that students felt most strongly and is arguably the most significant type of maths anxiety to the context of GCSE resits in further education. Almost a third of the respondents agreed that mindfulness could help them to stay calm when doing maths and the surveys showed a reduction in anxiety around evaluative scenarios that occur in class and in exams.

Student engagement with the sessions was affected by the timing and circumstances of the delivery. Some students were not able to consistently access the online delivery while the delivery model that took place face-to-face but during an assessment period also suffered from patchy attendance. The aspects of the programme that students reported as finding most useful were the mindfulness practices delivered in class and the associated home practices that were made available to them. A case study revealed that even a learner who experienced significant benefits from the mindfulness session stopped the practices when the intervention was over because she felt she did not have the time to meditate in her day-to-day life. This indicates that the structured nature of the intervention helped with student engagement and suggests that a longer intervention would prolong the benefits.

Recommendations

Organisations that have access to well-trained mindfulness teachers or who are able to offer experienced teachers the chance to train in mindfulness delivery should develop this resource in order to support learner well-being and reduce maths anxiety for a significant proportion of learners

- Mindfulness delivery should ideally happen face-to-face, should be introduced as early in the academic year as is practical and should be regularly ‘topped up’ by in-class practice
- In-class delivery should be supported by access to home resources – guided meditations that learners can download and use whenever they want

References

Ager, K., Albrecht, N. and Cohen, M. (2015) *Mindfulness in Schools Research Project: Exploring Students' Perspectives of Mindfulness.* RMIT University, Melbourne, Australia.

Ashcraft, M. (2002). Maths Anxiety: Personal, Educational and Cognitive Consequences. *Current Directions in Psychological Science*, *11*(5), pp. 181-182.

Chikvaidze, Mari Mindful Maths: Can we boost problem solving skills in Statistics using mindfulness? https://www.researchgate.net/profile/Mari-Chikvaidze/publication/303609070_Mindful_Maths_can_we_boost_problem_solving_skills_in_Statistics_using_mindfulness/links/5749de0708ae2e0dd3018646/Mindful-Maths-can-we-boost-problem-solving-skills-in-Statistics-using-mindfulness.pdf

Hembree, R. (1990). The Nature, Effects, and Relief of Mathematics Anxiety. *Journal for Research in Mathematics Education*, *21*(1), pp. 33–46. https://doi.org/10.2307/749455

Hunt, T. E. et al (2011) 'The development and part validation of a U.K. scale for mathematics anxiety', Journal of Psychoeducational Assessment, 29 (5), pp. 455-466.

Janz, P., Dawe, S., Wyllie, M. (2019) *Mindfulness-Based Program Embedded Within the Existing Curriculum Improves Executive Functioning and Behavior in Young Children: A Waitlist Controlled Trial.* School of Applied Psychology, Griffith University, Mount Gravett, QLD, Australia.

John Buck, Jennifer E., "Consequences of Math Anxiety and Stereotype Threat: An Intersectional Perspective" (2019). UNLV Theses, Dissertations, Professional Papers, and Capstones. 3811.

Lyons, I. M., and Beilock, S. L. (2012b). Mathematics anxiety: separating the math from the anxiety. *Cereb. Cortex* 22, 2102–2110. doi: 10.1093/cercor/bhr28

Richardson, F. C., and Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale. Journal of Counselling Psychology, 19, 551-554.

Tashana S. Samuel & Jared Warner (2019): "I Can Math!": Reducing Math Anxiety and Increasing Math Self-Efficacy Using a Mindfulness and Growth Mindset-Based Intervention in First-Year Students, Community College Journal of Research and Practice

Weare, K. and Huppert, F. (2019) *Mindfulness and Education.* Oxford Bibliographies, Psychology.

Weger, U. et al (2012) Mindful maths: Reducing the impact of stereotype threat through a mindfulness exercise, *Consciousness and Cognition*, 21 (1), pp 471-475

Wilde, S., Sonley, A., Crane, C. *et al.* Mindfulness Training in UK Secondary Schools: A Multiple Case Study Approach to Identification of Cornerstones of Implementation. *Mindfulness* **10,** 376–389

Appendix 1 – Mental and Written Maths Test 1

(Please note that learners were not able to see the higher level of numbering for the questions, so there was no confusion as to the numbering of the quiz questions)

Mental and Written Maths Test 1

Welcome to the first of the online maths tests for the Mindfulness Action Research Project.

There are 10 questions.
You can expect to spend approximately 10 minutes on the test.
If you find that after 20 minutes you have not completed the test, please enter '0' for the remaining questions and move on to section 2.

Please complete this online test without using a calculator.
You should have some paper and a pen or pencil to carry out calculations by hand.
If you usually have someone read to you in exams, you may have someone read the questions to you.

You should not look up the answers on the internet or ask others to help you work out the problems.
It is important that your answers are your own work and that you do not use a calculator to help you.

This test does not go towards your GCSE grade and your results will not be viewed by anyone except your teacher. Your name will be removed from your test results when your data is used in the project.

This test is an important way of measuring what impact the mindfulness course may have on how students experience maths.

After you complete the maths test, section 2 contains a few questions about how it made you feel.

Thank you for participating in the Mindfulness Action Research project.

The respondent's email (**null**) was recorded on submission of this form.
*Required

1. Email *

2. 1) What is half of 58? * 1 point

Appendix 1 – Mental and Written Maths Test 1 (cont.)

3. 2) You get on a bus at 9.45 am. The bus ride is 40 minutes long. What time do you get off the bus? * 1 point

4. 3) Calculate 14 + 37 * 1 point

5. 4) Calculate 84 - 29 * 1 point

6. 5) Calculate 27 x 35 * 1 point

7. 6) Calculate 295 ÷ 5 * 1 point

8. 7) Calculate 1.35 + 0.78 * 1 point

9. 8) Calculate 3.6 - 1.05 * 1 point

10. 9) Which of the following numbers is the smallest number? 2.02, 2.1, 2.12, or 2.201 * 1 point

Appendix 1 – Mental and Written Maths Test 1 (cont.)

11. 10) At a cafe, a coffee is £2.50 and a muffin is £1.75. I buy two coffees and one muffin. I pay with a £10 note. What is my change? (please use proper money notation) * 1 point

Thank you for completing the test. Your participation is helping us to complete our research. Please answer the next few questions about how you felt taking the test.

12. How anxious did you feel while completing this test? *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

13. During the test, how much did your mind 'go blank'? *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

14. Roughly how much time did you spend on the test? *

15. Do you have any other comments on how the test made you feel?

Appendix 2 – Maths Anxiety Scale 1

Maths Anxiety Scale

Please complete this short survey about how you experience maths.

The survey is 16 questions long. It will likely take less than 20 minutes to complete.

Please take your time. Read the questions carefully.

If you usually have someone read for you in class, you may want someone to help you with this survey.

Please answer honestly, as your responses form part of our research.

*Required

1. Email *

How anxious would you feel...

2. Having someone watch you multiply 12 x 23 on a piece of paper. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

3. Adding up a pile of change. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

Appendix 2 – Maths Anxiety Scale 1 (cont.)

4. Taking a maths exam. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

5. Reading the word "algebra". *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

6. Calculating a series of multiplication problems on paper. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

7. Working out how much time you have left before setting off to your work place or place of study. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

8. Listening to someone talk about maths. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

Appendix 2 – Maths Anxiety Scale 1 (cont.)

9. Deciding how much each person should give you after you buy an object that you are all sharing the cost of. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

10. Sitting in a maths class. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

11. Being given a surprise maths test in a class. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

12. Watching a teacher/lecturer write equations on the board. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

13. Being asked a maths question by a teacher in front of a class. *

Mark only one oval per row.

	1 - Not at all	2 - Slightly	3 - A fair amount	4 - Much	5 - Very Much
Choose one	◯	◯	◯	◯	◯

Appendix 2 – Maths Anxiety Scale 1 (cont.)

14. How often would you agree with this statement: "I get really tense while taking maths tests." (Choose one) *

Tick all that apply.

- [ ] Always disagree
- [ ] Sometimes disagree
- [ ] Uncertain
- [ ] Sometimes agree
- [ ] Always agree

15. How often would you agree with this statement: "My mind goes blank and I am unable to think clearly when doing maths activities." (Choose one) *

Tick all that apply.

- [ ] Always disagree
- [ ] Sometimes disagree
- [ ] Uncertain
- [ ] Sometimes agree
- [ ] Always agree

16. How often would you agree with this statement: "I get a sinking feeling when I think of trying hard maths problems." (Choose one) *

Tick all that apply.

- [ ] Always disagree
- [ ] Sometimes disagree
- [ ] Uncertain
- [ ] Sometimes agree
- [ ] Always agree

17. Do you have any other comments about your experiences of maths?

Appendix 3 – Maths Anxiety Scale 2 (additional content only)

(Please note that the second MAS questionnaire contained the same questions as the first questionnaire, with the addition of the following questions.)

Experience of Mindfulness

18. There were 4 mindfulness sessions delivered in class. How many mindfulness sessions did you attend? *

Mark only one oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ I can't remember
- ◯ None

19. How many times did you try the home practice? *

Mark only one oval.

- ◯ Once or twice
- ◯ Three or four times
- ◯ Five to eight times
- ◯ Nine times or more
- ◯ I didn't try any of the home practices

20. If you did not try any of the home practices, can you please give a brief explanation why you didn't try them:

Appendix 3 – Maths Anxiety Scale 2 (cont.)

21. Which parts of the .breathe mindfulness programme did you find useful? Tick as many as apply. *

Tick all that apply.

- [ ] The mindfulness meditations we did in class
- [ ] Home practices
- [ ] Learning about how my brain responds to stress and worry
- [ ] Learning about how my body responds to stress and worry
- [ ] Learning about the cycle of thoughts, emotions, body sensations and actions
- [ ] I didn't find any part of the mindfulness programme useful

Other: [ ] _____

22. If you clicked 'Other' for the above question please give more detail here:

_____

How do you feel about the following statements:

23. "I feel that mindfulness practices could help me stay calm when doing maths" *

Mark only one oval.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly Disagree

Appendix 3 – Maths Anxiety Scale 2 (cont.)

24. "I feel that mindfulness practices could benefit me in my day to day life." *

Mark only one oval.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly Disagree

25. "I feel that the mindfulness sessions were a good use of class time." *

Mark only one oval.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly Disagree

26. Do you want to share anything else about your experience of studying mindfulness in maths class? *

Thank you for completing this survey! You are contributing to research and helping us to improve our teaching and learning.