RESEARCH ARTICLE

Investigating the relationship between mathematics anxiety, mathematical resilience and mathematics support engagement: an analysis of demographic and cohort factors

Farhana Gokhool, **sigma**, Coventry University, Coventry, England. Email: lunatf@uni.coventry.ac.uk
Duncan Lawson, **sigma**, Coventry University, Coventry, England. Email: mtx047@coventry.ac.uk
Mark Hodds, **sigma**, Coventry University, Coventry, England. Email: ab7634@coventry.ac.uk

Abstract

Engagement with mathematics support has been of interest for several years, particularly because some students who may benefit from using support do not avail themselves of it. It has been suggested that these students may be those who are mathematics anxious; they may have had previous negative learning experiences with mathematics and thus demonstrate avoidance behaviours such as procrastination and not seeking help. In this paper, the results of mathematical resilience (MR) and anxiety questionnaires (MA) will be investigated. This investigation is conducted at the level of the whole cohort of students and also broken down by a range of demographic features. Consideration is also given to whether there is any relationship between student mathematics anxiety and resilience on the one hand and whether or not they engage with mathematics and statistics support services on the other.

The analysis reveals a weak negative correlation between MA and MR at whole cohort level. In terms of demographic characteristics, students on courses with no mathematics A-level entry requirement were significantly more mathematics anxious than those on courses with a mathematics A-level entry-requirement. They were also less mathematically resilient. Female students, non-Asian students, mature students and disabled students, on average, also had higher MA scores, whilst female students and mature students were also significantly less mathematically resilient.

Keywords: mathematics anxiety, demographics, mathematics resilience, entry-requirements, mathematics support.

1. Introduction

Mathematics anxiety (MA) is defined to be, "a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in … ordinary life and academic situations" (Richardson and Suinn, 1972; p.551). It is a debilitating disorder that can arise from previous negative experiences with mathematics and may in fact be worsened due to the method by which mathematics is taught in UK secondary schools, which has been likened to a form of "cognitive abuse" (Johnston-Wilder and Lee, 2010). Students with MA may avoid mathematics because the brain sees mathematics as a traumatic situation and a fight or flight response is triggered. The emotional response in the brain increases with the severity of the mathematics anxiety and this causes stronger responses in the more anxious students (Marshall et al., 2017). When the brain is in this state, it is unable to think logically and therefore cannot process mathematics effectively, meaning that attempting to learn whilst in this state may not be worthwhile. This shows that avoidance of mathematics or procrastination is potentially an automatic response in students, rather than it being their fault. When students are unable to avoid mathematics, they may end up using self-sabotaging behaviours such as not studying regularly or not seeking help where necessary.

Identifying MA as an obstacle to effective learning in students is potentially the first step towards overcoming it (Uusimaki and Kidman, 2004). Teaching students to become mathematically resilient (MR) (having a positive affective stance to mathematics), can further assist students in tackling mathematics anxiety and students can become effective learners. Lee and Johnston-Wilder (2014) describes MR as being a 3- dimensional construct, with dimensions of growth, value and struggle, with mathematically resilient students believing that:

1. Anyone can learn mathematics; and

2. There is value in learning mathematics; and

3. Struggle is a normal part of learning.

As noted above, where mathematically anxious students cannot avoid mathematics, they may sometimes adopt self-sabotaging behaviours such as not seeking help when it is needed. This may be reflected in their unwillingness to engage with mathematics and statistics support (MSS) services. MSS aims to provide support to all students, but the support offered is on a voluntary basis. Students have to take the initiative to engage with the support on offer. Therefore, this research aims to understand the extent to which MA and MR play a part in engagement with MSS.

Since MA can lead to avoidance behaviours, it is interesting to explore whether levels of MA differ with course of study. It is also beneficial to understand whether MA is more prevalent in specific demographic groups so that, if there is evidence of this, future work can be focussed on tailoring interventions towards lowering MA levels in these demographic groups.

2. Methodology

There are a number of published scales for measuring MA (e.g., Hopko et al., 2003; Núñez-Peña, Guilera, and Suárez-Pellicioni, 2014) and one key scale for measuring MR. In this study, Kooken et al.'s (2013) mathematical resilience questionnaire (retrieved from Johnston-Wilder et al., 2014) and Betz's (1978) mathematics anxiety questionnaire were used to determine respondents' anxiety and resilience level. These scales have been previously used in studies of MA and MR amongst higher education students (Johnston-Wilder et al, 2014). The MR scale ($\alpha = 0.856$) has three subscales (Value: 8 items ($\alpha = 0.841$; Struggle: 8 items $\alpha = 0.762$; Growth: 7 items $\alpha = 0.751$), whilst the MA questionnaire has 10 items ($\alpha = 0.910$). In both the MA and MR scale, respondents are asked to indicate their level of agreement with each item using a 5-point Likert scale (strongly disagree through to strongly agree). Some items are positively worded whilst others are negatively worded (when scoring negatively worded questions the order is reversed to ensure consistency). Sample items are shown below:

MA (positively worded) I usually don't worry about my ability to solve maths problems

MA (negatively worded) My mind goes blank and I am unable to think clearly when working on mathematics

MR (value subscale) Maths is very helpful no matter what I decide to study

MR (struggle subscale) Good mathematicians experience difficulties when solving problems

MR (growth subscale) People are either good at maths or they aren't

The questionnaires were distributed primarily through attaching them to diagnostic tests and were answered by students on a variety of courses. These diagnostic tests were delivered to several

Coventry University course cohorts at the start of their studies to ascertain their level of preparedness in mathematics. At the start of semester one, students were sent a link via email to complete the diagnostic test through OnlineSurveys. Upon completion of the diagnostic test, students were prompted to continue and complete the MR and MA questionnaire. This encouragement made clear that participation was voluntary and not linked to the diagnostic assessment they had just completed. It was hoped that this method of data collection could be repeated in semester 2 to recruit new participants. However, due to changing university processes, the questionnaires could not be added to the diagnostic test, so this approach was not possible. As an alternative, the link to the MA and MR questionnaires was added to the post-diagnostic test email sent out to students giving them their personal diagnosis. This gave a significantly lower response rate. Other methods of participant recruitment included advertisement to students attending mathematics and statistics support drop-in sessions, lectures and course noticeboards.

Data on student demographic characteristics was obtained from the University student record system (participants having given permission for this). Whether or not a student engaged with MSS up to and including the end of the 2020-21 academic year was determined from the attendance records of the MSS service.

Ethical approval for the study was given by Coventry University Research Ethics Committee.

3. Results

3.1. Questionnaires

A total of 488 responses were received, with 395 students completing all resilience questions and 409 completing all the anxiety questions. A five-point Likert scale was used for both scales; responses were scored 1 to 5 (strongly disagree to strongly agree) for positively worded items and reverse scored for negatively worded items. A student score for each construct was calculated by determining their mean item score. Consequently, scores range from one to five, with one meaning a student was not mathematics anxious or resilient at all, and five being a student had the highest possible level of mathematics anxiety or mathematical resilience. The descriptive statistics for both scales can be found in Table 1.

Table 1: Descriptive statistics for both the mathematics resilience and mathematics anxiety scale

Questionnaire	N	Median score	Mean score	Minimum	Maximum
Mathematics resilience	395	4.04	4.01	2.13	4.96
Mathematics anxiety	409	3.10	3.11	1	5

The range for the anxiety results is much wider than that of the resilience, where it seems as though scores are more positively skewed, perhaps because a certain level of MR is needed to attend university and study a course which may have some mathematics content. On the other hand, students' anxiety levels here are seen to range from having little to no evidence of mathematics anxiety to the highest possible levels of mathematics anxiety.

3.2. Correlation between MA and MR

Figure 1 shows a scatter plot of mean MR score against mean MA score. MA and MR were found to be weakly negatively correlated, r = -.221, p < .001.

Pearson's correlation for MA score with MR score

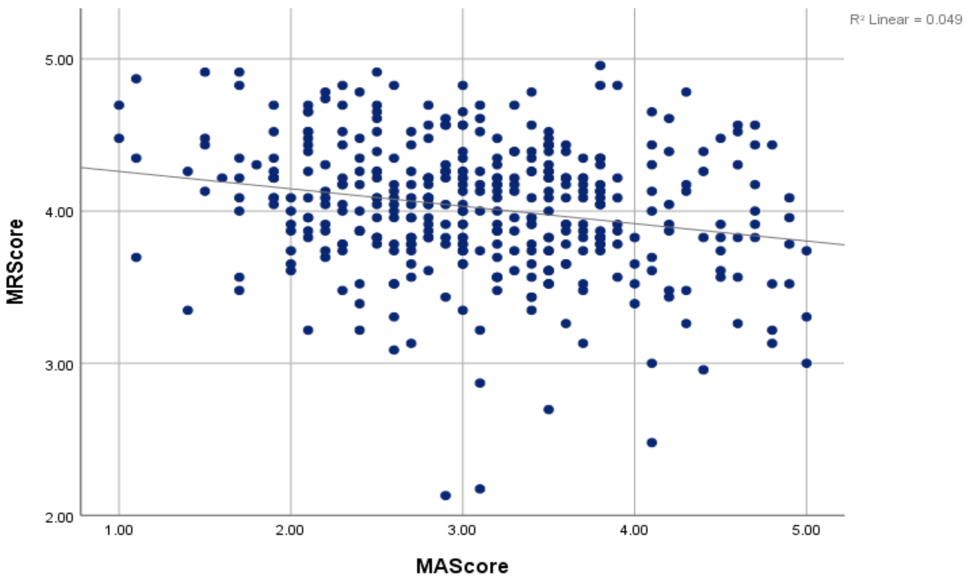

Figure 1: Correlation between students' average MA and MR score

The relationship between mathematics resilience and anxiety is to be expected (Trigueros et al., 2020), with students displaying elevated levels of mathematics anxiety generally having lower levels of mathematics resilience. There are some outliers, and these may be students that are resilient enough to overcome their anxiety and succeed with the mathematics in their course, whilst students with scores above 4 for MA or below 2 for MR are a cause for concern. This is because a score above 4 for MA would suggest that a student has agreed with most/all of the items, whilst scores below 2 for MR would indicate that a student has disagreed with most of the items (since the response categories were set from "strongly disagree" to "strongly agree"). It is worthwhile to note that no students had an MR score of below 2, though a considerable number did have an MA score above 4 (with three students having the highest possible score of 5).

3.3. MR and MA score by course

Students from several different courses completed the questionnaire. To make analysis by course practical, students were grouped according to their courses' mathematics entry requirement, as seen in Table 2.

Mechanical engineering and mathematics were examples of courses in the mathematics A-level required group, economics and some other engineering courses were in the mathematics A-level recommended group, whilst biosciences and nursing were classed as no A-level requirement.

Table 2: Number of respondents, and the standard deviation and mean for their resilience score, broken down by course mathematics entry requirements

Course	N	SD	Mean MR
No A-level requirement	222	0.44	3.93
A-level recommended	51	0.38	4.11
A-level required	122	0.40	4.13

The difference in MR between students on courses where A-level mathematics was either recommended or required is minimal. However, there is little larger difference when considering students on courses with no A-level requirement. A one-way ANOVA was performed to compare the effect of course mathematics entry requirements on MR score, which revealed that there was a statistically significant difference requirement between at least two groups ($F(2, 392) = 10.433$, $p < 0.001$). A post-hoc Bonferroni correction found that the mean value of MR was significantly different between no A-level requirement and A level recommended, $p = .017$, 95% C.I. = [-.338, -.024]), and between no A-level requirement and A level required, $p < .001$, 95% C.I. = [-.314, -.086]). There was no statistically significant difference between A-level required and A-level recommended ($p=1.000$) as expected from observing Table 2.

It is important to note here that some students may have an A-level in mathematics (or equivalent) but do not study a course where this is required. Future analysis will investigate the relationship, if any, between students' prior qualifications and their mean MA and MR.

However, when looking at MA in these students, there is a notable difference in mean MA scores between all three groups, as seen in Table 3.

Table 3: Number of respondents, and the standard deviation and mean for their anxiety score, broken down by course mathematics entry requirements

Course	N	SD	Mean MA
No A-level requirement	234	0.87	3.34
A-level recommended	51	0.66	3.01
A-level required	124	0.69	2.72

The Mean MA score for students on courses with no A-level mathematics entry requirement is 23% higher than that for students on course with an A-level mathematics entry requirement.

Though there is more variability in mean MA score when considering students on courses with no mathematics A-level requirement, their mean MA score firmly places these students more in the maths anxious category than students in courses with a required maths A-level, who could be categorised as not very maths anxious at all. A one-way ANOVA found there was a statistically significant difference between at least two groups ($F(2, 406) = 24.624$, $p < 0.001$). A post-hoc Bonferroni correction found that there were significant differences in the mean MA score of two of the three pairs, with the test between no A-level requirement and A level recommended returning p = .027, 95% C.I. = [.027, .619], and between no A-level requirement and A level required returning p < .001, 95% C.I. = [.403, .828]). There was no statistically significant difference between A-level required and A-level recommended (p=.084), perhaps surprisingly since the MA score between the two groups differed by a similar amount to the difference in MA score between no A-level requirement and A-level recommended.

3.4. MA and MR by engagement and demographic characteristics

One purpose of this research is to investigate if levels of MA and MR impact on student engagement with MSS. Another purpose is to explore whether specific demographic groups have higher (or lower) MA and MR levels. Table 4 shows a breakdown of the data by various characteristics (the rows "Visited" and "Not visited" refer to students who attended the mathematics and statistics support drop-in provision at least once during the academic year). For each characteristic shown in Table 4 (engagement, gender, ethnicity, age, disability), t-tests were run with this as the independent variable and, in turn, MA and MR as the dependent variable.

Table 4: Mean MR and MA scores broken down by various characteristics and t-test statistics

Characteristics		N	SD	MR	t	p	N	SD	MA	t	p
Engagement	Visited	37	.42	3.85	-2.39	.017	39	.88	3.28	1.33	.185
	Not visited	374	.42	4.02			389	.84	3.09		
Gender	Male	193	.44	4.08	-3.25	.001	197	.69	2.85	6.12	<.001
	Female	218	.41	3.95			231	.89	3.33		
Ethnicity	Non-white	150	.44	4.02	.424	.672	157	.75	3.00	-2.01	.050
	White	245	.43	4.00			252	.89	3.18		
Age	Mature	157	.47	3.94	-2.80	.005	165	.91	3.29	3.66	<.001
	Non-mature	254	.40	4.06			263	.77	2.99		
Disability status	Disability	64	.49	4.00	-.187	.852	71	.82	3.34	2.55	.011
	No disability	331	.42	4.01			338	.84	3.06		

These results show that, somewhat surprisingly, those that did not engage with MSS were statistically significantly more resilient than those that did visit. Additionally, those that visited were more mathematically anxious than those who did not, though this difference was not significant. We might hypothesise that the reasonably high levels of mathematical resilience amongst the students who did visit (3.85) was helping them offset their moderately elevated levels of mathematics anxiety (3.28) so that they did not succumb to self-sabotaging behaviour such as not seeking help. We might further hypothesise that the almost middle mathematical anxiety score of those who did not visit (3.09) allied with high mathematical resilience (4.02) led to these students not feeling in need of additional support. However, the sample size for those that visited is relatively small (and only about 10% of the sample size of those that did not visit). A larger sample size may be needed for more meaningful results.

The respondent numbers by gender were similar, and it was found that male students were significantly more resilient than female students. A similar trend can be seen in their MA scores, where females are, on average, significantly more mathematics anxious than male students, (although there is more variability in the scores of female students). Since three is the middle score on the range of possible scores for MA (which is one to five), the results in Table 4 show that female students' anxiety is above this middle anxiety level, whilst that of male students is below the middle.

In a first investigation of whether there is a difference in MR and MA scores between students of different ethnicities, all non-white ethnicities were amalgamated into a single category. The MR scores for both groups were remarkably similar and, not surprisingly, the small difference was not statistically significant. This was not the case when comparing the mean MA scores, where non-white students are significantly less maths anxious than white students. To investigate both these findings in more detail, the MR scores of the amalgamated non-white category has been subdivided, as shown in Table 5.

Table 5: Mean resilience and anxiety score broken down by ethnicity

Ethnicity	N	SD	Mean MR	N	SD	Mean MA
South Asian	44	.41	4.03	46	.56	2.91
Asian Chinese/Asian Other	19	.39	4.13	20	.75	2.81
Black	53	.48	4.00	56	.83	3.11
Mixed	21	.33	4.03	22	.69	3.05
Other/unknown	13	.61	3.92	13	1.07	3.11
White	245	.43	4.00	252	.89	3.18

From Table 5, we see that Asian Chinese/Asian Other students are on average more mathematically resilient than any other ethnic group (4.13), whilst South Asian, Black, White, and Mixed students all have an MR score of around 4. Other/unknown students are the least mathematically resilient (3.92), but it should be noted that this was the smallest group (there were only 13 students in this category).

The differences in mean MA are quite revealing. It appears that Asian students overall are less mathematically anxious than all other ethnicity groups. They are the only two groups to have a mean MA score below the middle. To determine whether this result was significant, the data was again aggregated to form two groups: Asian and non-Asian, which can be seen in Table 6.

Table 6: Mean MA scores broken down by ethnicity (Asian and non-Asian)

Ethnicity	N	SD	Mean MA	t(407)	p
Asian	66	.62	2.88	-2.48	.01
Non-Asian	343	.87	3.15		

As hypothesised, Asian students are significantly less maths anxious than non-Asian students, with p=.01.

Returning to Table 4, we see that mature students are significantly less mathematically resilient than young students. However, mature students still have a high MR score (3.94). This may be because mature students have learnt, through experience in the workplace about the value of mathematics (one of the subscales of the resilience construct). We also see that mature students are more anxious than young students and this difference is significant. This is consistent with the findings of Durrani and Tariq (2009) and will not surprise mathematics and statistics support practitioners who frequently encounter mature students expressing their concerns about both not having studied mathematics for many years and also not having been very good at the subject when they were at school. It would appear that the relatively high-level MR of such students allied with their anxiety levels motivates them to seek help (whereas if they had low levels of MR they might avoid MSS).

The final factor investigated was disability. There is virtually no difference in MR scores between students with a declared disability and those without. However, it was found that disabled students were significantly more mathematically anxious than students that are not, with p=0.011. It may be that disabled students are generally more anxious about their education, possibly because of difficulties in the past when accessing the support they needed. It should also be noted that the amalgamation of all types of disability into a single category is unsatisfactory because of the wide range of different types of disability and resulting different experiences of students. However, the small number of students who declared a disability required this amalgamation in order to carry out a meaningful statistical analysis.

4. Statistical modelling

To ascertain what factors influenced MA and MR score when combined, an ANCOVA was conducted. In both cases, MA and MR were added as covariates since it has already been found that a significant negative correlation existed between the two variables.

4.1. Mathematics Resilience

When MR score was considered as the dependent factor, course entry requirements, engagement, and MA score all were shown to have a significant effect. Further statistical detail can be seen in Table 7.

Mathematics A-level required was used as a reference category, and it can be seen that students on a course with no mathematics A-level requirement have significantly lower MR scores than those on a course with a mathematics A-level requirement (which is the reference category for course type). However, the difference between the reference category and the courses with mathematics A-level only being recommended is not statistically significant. Either way, the type of course a student studies does have an effect on students' MR score. Furthermore, after adjusting for the type of course, overall, students that visited the drop-in centre had lower MR scores than those who did not. MA score also returned a significant result, showing that as expected, it provides an explanation for some of the variation in MR score that is not accounted for by the other variables.

Table 7: Beta and p-values for reduced ANCOVA model for MR

Parameter	β	p
No mathematics A-level requirement	-.15	.004
Mathematics A-level recommended	-.018	.802
Visited	-.17	.023
MA Score	-.82	.003

4.2. Mathematics Anxiety

Table 8: Beta and p-values for reduced ANCOVA model for MA

Parameter	β	p
No mathematics A-level requirement	.408	<.001
Mathematics A-level recommended	.278	.034
Disability	.288	.007
Female	.207	.051
MR Score	-.306	.001

The analysis determined that MA was influenced both by course entry requirements and disability, along with MR score. Despite the fact that gender was not a significant predictor of MA score, it was included in the model since it had p=.051 and was observed to have a significant effect on MA when t-tests were performed on the data in Table 4. Its lack of significance in the ANCOVA model suggests that there may be some interaction between it and another variable.

5. Discussion

The correlation between MA and MR indicates that those with higher levels of MA tend to have lower levels of MR. This was initially a concern as it raises the question of how students with low MR scores would overcome their MA enough to access MSS. However, it was found that students who visited had higher levels of MA than those who did not, though this was not a significant result. Therefore, this provides some evidence that raised levels (i.e., above 3) of MA may actually promote engagement with MSS. Further to this, those that visited the centre were significantly more likely to have lower MR scores than those that did not visit, though the MR scores of those who did visit cannot necessarily be classed as low – 3.85 is actually relatively high for an MR score (possible scores range from one to five). Those that have very high MR scores (above 4) may be less inclined to access drop-in support because mathematically resilient students may be more likely to know of, and use, many avenues of support (Lee and Johnston-Wilder, 2017), such as asking their lecturers or working with their peers, rather than having MSS centres as their first port of call. However, the population distribution in this research is skewed heavily towards non-visitors, meaning a larger sample size will be needed if these results are to be reliable.

The results of Section 3 further indicate that the MA score differs significantly for each demographic characteristic considered. On the other hand, MR differs significantly only by gender and age, and not by ethnicity (white and non-white) or disability. Neither gender, ethnicity nor age were found to significantly influence MA or MR scores in the ANCOVA analysis. However, the mathematics entry requirements of the course a student studies did appear to have a significant effect.

MA has been shown to be greater among female students in previous studies (Durrani and Tariq, 2009; Joyce et al., 2006; Mutodi and Ngirande, 2014), thus it is possible that the results for the ANCOVA analysis are being confounded by an interaction with another factor. However, Hembree (1990) found that though female students reported higher levels of MA, it did not result in greater mathematics avoidance behaviours, whereas it did for male students. This result is suggested to be potentially caused by females being more willing to admit their anxiety, and females coping with anxiety better.

It may be that the factor confounding the results for the effect of gender or age on MA and MR in the ANCOVA analysis is the mathematics entry requirements of the course a student studies. Students that responded to the questionnaire were primarily either from engineering or health science courses. Engineering is dominated by male students, whereas adult nursing and biosciences have a mainly female population and also a higher mature student population. Engineering courses also tend to have either a mathematics A-level requirement or it is recommended, which is generally not the case for Health Science courses. In Table 2 and 3, it can be seen that those studying courses where no A-level mathematics is required have higher MA scores and lower MR scores than the students studying either of the other course types. Therefore, it may be possible that there is some interaction between these variables, which further research will focus on.

Asian students had significantly lower MA scores than non-Asian students, which, when looking at the mathematics culture for Asian students, may be expected, particularly East Asian students, where they “see math to be less challenging than their western counterparts who “expect” math to be difficult” (Stankov, 2010). White students had the highest level of MA. No other study that we are aware of has investigated MA scores among different ethnic groups, thus more research will be done in this area to see if these findings can be consolidated, and what may be done to target demographic groups with high MA levels.

Mature students were found to be significantly more mathematics anxious and also had lower MR scores. This may be explained by the time spent away from education, and thus, studying any mathematical content formally.

Students with a disability could have a learning difference, a mental disability or a physical disability, or a combination. For the purpose of the analysis, these students were grouped together, though it is noted that accessibility and providing an inclusive space for these students will not necessarily look the same. There was virtually no difference in the MR score between the two groups of students, though it was found that students with a disability had a significantly higher MA score.

6. Conclusions and future work

This research aimed to determine what factors influenced MA and MR scores in students that responded to an MA and MR questionnaire. Mostly students who did not engage with MSS responded, which gave an interesting insight into the MA and MR scores of non-users of mathematics support.

Course mathematics entry requirements, disability, and MR score appeared to significantly impact the MA score of students, whilst course mathematics entry requirements, engagement with MSS and MA score appeared to significantly impact MR score of students. Gender did not return a p-value below 0.05 for either ANCOVA analysis, despite t-tests showing it did have a significant impact on both MA and MR. This suggests there may be an interaction between gender and another factor, although it has been surmised this factor interaction may be with the mathematics entry requirements of the course a student is studying.

Data collection will continue for the next academic year, with focus placed particularly on finding students who have engaged with mathematics support. Alternative questionnaires will be delivered to statistics students to measure their statistics anxiety, and both mathematics resilience interventions and statistics anxiety interventions will be delivered to students, the success of which will be measured through post-intervention questionnaires.

7. References

Betz, N. E., 1978. Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology*, 25(5), pp.441-448. https://psycnet.apa.org/doi/10.1037/0022-0167.25.5.441

Durrani, N. and Tariq, V., 2009. Relationships between undergraduates' mathematics anxiety and their attitudes towards developing numeracy skills and perceptions of numerical competence. In: *2nd International Conference of Education, Research and Innovation*, Madrid, pp. 787-794.

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

Hopko, D.R., Mahadevan, R., Bare, R.L. and Hunt, M.K., 2003. The abbreviated math anxiety scale (AMAS) construction, validity, and reliability. *Assessment*, 10(2), pp.178-182. https://doi.org/10.1177/1073191103010002008

Johnston-Wilder, S. and Lee, C., 2010. *Developing mathematical resilience*, Paper presented at the 2010 BERA annual conference at Warwick University.

Johnston-Wilder, S., Brindley, J. and Dent, P., 2014. *A survey of mathematics anxiety and mathematical resilience among existing apprentices*. London: The Gatsby Foundation.

Joyce, J., Hassall, T., Montaño, J.L.A. and Anes, J.A.D., 2006. Communication apprehension and maths anxiety as barriers to communication and numeracy skills development in accounting and business education. *Education + Training*. 48(6), pp.454-464. https://doi.org/10.1108/00400910610692967

Kooken, J., Welsh, M.E., Mccoach, D.B., Johnson-Wilder, S. and Lee, C., 2013. Measuring mathematical resilience: an application of the construct of resilience to the study of mathematics. In: *American Educational Research Association (AERA) 2013 Annual Meeting: Education and Poverty: Theory, Research, Policy and Praxis*, 27 Apr - 1 May 2013, San Francisco, CA, USA.

Lee, C., and Johnston-Wilder, S., 2014. Mathematical resilience: what is it and why is it important? In: Chinn, Steve ed. *The Routledge International Handbook of Dyscalculia and Mathematical Learning Difficulties.* Abingdon: Routledge, pp.337-345.

Lee, C. and Johnston-Wilder, S., 2017. The construct of mathematical resilience. In *Understanding emotions in mathematical thinking and learning*, pp. 269-291. Academic Press.

Marshall, E.M., Staddon, R.V., Wilson, D.A. and Mann, V.E., 2017. Addressing maths anxiety and engaging students with maths within the curriculum. *MSOR Connections*, 15(3), pp. 28-35. https://doi.org/10.21100/msor.v15i3.555

Mutodi, P. and Ngirande, H., 2014. Exploring mathematics anxiety: Mathematics students' experiences. *Mediterranean Journal of Social Sciences*, 5(1), pp.283-283. https://doi.org/10.5901/mjss.2014.v5n1p283

Núñez-Peña, M.I., Guilera, G. and Suárez-Pellicioni, M., 2014. The single-item math anxiety scale: An alternative way of measuring mathematical anxiety. *Journal of Psychoeducational Assessment*, 32(4), pp.306-317. https://doi.org/10.1177/0734282913508528

Richardson, F.C. and Suinn, R.M., 1972. The mathematics anxiety rating scale: psychometric data. *Journal of Counseling Psychology*, 19(6), pp.551-554. https://psycnet.apa.org/doi/10.1037/h0033456

Stankov, L., 2010. Unforgiving Confucian culture: A breeding ground for high academic achievement, test anxiety and self-doubt?. *Learning and Individual Differences*, 20(6), pp.555-563. https://psycnet.apa.org/doi/10.1016/j.lindif.2010.05.003

Trigueros, R., Aguilar-Parra, J.M., Mercader, I., Fernández-Campoy, J.M. and Carrión, J., 2020. Set the Controls for the Heart of the Maths. The Protective Factor of Resilience in the Face of Mathematical Anxiety. *Mathematics*, 8(10), Article 1660. https://doi.org/10.3390/math8101660

Uusimaki, L. S. and Kidman, G. C., 2004. Reducing maths-anxiety: Results from an online anxiety survey. Accessed via http://eprints.qut.edu.au/974/1/kid04997.pdf [Accessed: 19 January 2022].