Attitudes and anxiousness about maths

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Abstract

A fear or dislike of mathematical subjects is commonplace amongst students outside the mathematical sciences, but for some students, their anxiety about maths has a serious impact on their ability to study the subject effectively. Traditionally, students with maths anxiety (MA) have avoided subjects known to contain maths or statistics. The rise in the use of statistics within most disciplines means that this avoidance is not always possible. The most effective strategy for reducing anxiety is to receive one-to-one support, but a lot of students with high maths or statistics anxiety levels do not visit maths support centres. This paper reports on a part of a long term collaborative project between the Maths and Statistics Help Centre (MASH) and Specialist Learning Difference (SpLD) service at the University of Sheffield to address student maths anxiety, evaluate the effectiveness of a number of strategies, and encourage attendance at MASH. This paper will summarise the findings of an initial survey of University of Sheffield students designed to investigate attitudes and anxiousness about maths.

1. Introduction

Maths anxiety can be described as "*feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a variety of ordinary life and academic situations*" (Richardson & Suinn 1972) and it is thought to affect up to 85% of students at some level (Perry, 2004). Whilst mild anxiety is to be expected, especially around exam time, 26% have moderate to high levels (Jones 2001), which has a serious impact on their ability to learn maths. Maths anxiety impacts on mathematical performance by interfering significantly with the working memory (Young et al. 2012), which is essential for successful problem solving. The thought of maths triggers negative memories and the default response is to run away. This leads to students not engaging with maths, poor preparation, and underperformance in exams which reinforces the students' view that they are bad at maths. This avoidance strategy also means that students opt out of maths as soon as possible, restricting their degree and career options (Ashcraft & Moore 2009).

1.1 Causes of Maths Anxiety

The genesis of maths anxiety is thought to lie in negative learning experiences early in education. Primary school teachers exhibit some of the highest levels of MA (Hembree 1990), often lacking confidence in their own subject knowledge. They can have negative beliefs about maths as a consequence of their own negative experiences with maths at school. As a result, they tend to stick to set rules and methods (Finlayson 2014) and often pass on their own anxieties to their students. Rote learning, lack of enthusiasm and timed high-stakes tests also contribute towards negative attitudes to maths, which can start in the early school years (Scarpello 2007). Maths teachers in secondary schools usually have broad mathematical knowledge but may be unable to explain concepts clearly, lack patience, make negative comments, or humiliate students in the classroom.

By the time students reach university, 93% of students have had a stressful or negative experience with maths (Jackson & Leffingwell 1999).
Parental beliefs and attitudes about maths can also influence the maths anxiety of their children (Scarpello 2007). Parents who themselves believe that they can't do maths are less likely to help their children with homework, and maths-anxious parents who provide frequent help with homework can increase a child's anxiety. In terms of gender differences, there is no difference between average maths scores of girls and boys, but girls report higher average maths anxiety levels, leading to underrepresentation in the field of maths (Tomasetto, Alparone and Cadinu, 2011). Finally, students with dyslexia (Jordan et al. 2014) and dyscalculia (Rubinsten & Tannock 2010) are at greater risk of maths anxiety.

2. Methods

In order to collect views on studying maths and possible factors influencing maths anxiety, a questionnaire was designed and all students at Sheffield University were invited to take part between Sept–Dec 2015. They were also invited to give their university registration number so anonymised demographics such as faculty and gender could be obtained from the university record, and 487 of the 573 respondents provided this data.
The questionnaire contained questions on attitudes and achievements at school, expectations for their study and the UK MARS scale. The Mathematics Anxiety Rating Scale (MARS) was originally developed by Richardson & Suinn (1972) and was constructed to provide a measure of anxiety associated with the single area of the manipulation of numbers and the use of mathematical concepts. However, there were some issues with the size of this scale and its use with British undergraduates, so the 23-item UK version of the MARS was used (Hunt et al. 2011). Comparisons were made using the total score for each student.

3. Results

In order to assess whether the respondents of the survey were representative of the population, a comparison of gender and faculty proportions with university figures was made. 57% of respondents to the survey were female, compared to 51% in the general university population. The faculty percentages were mostly similar, but there was an underrepresentation of the Faculty of Social Science by 12% and overrepresentation of the Faculty of Science by 10%. This difference will impact on numerous results because science students are more likely to have studied maths at a higher level and may be less anxious.

3.1 Attitudes and achievements at school

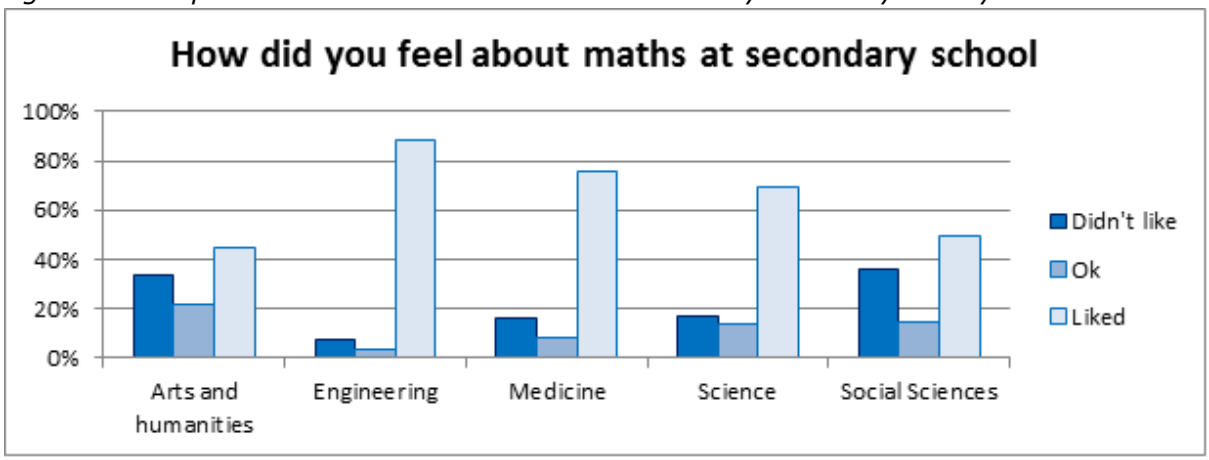
Overall, 52% of respondents had a maths qualification above GCSE Maths and 9% did not achieve a grade A*-C at GCSE Maths the first time. Students were asked how they felt about maths at primary and secondary school on a 5 point scale ranging from 'Hated it' to 'Loved it'. It was expected that some students would dislike maths from the beginning, but this number would grow in secondary school. The results suggest that there were only small differences between attitudes at primary and secondary school. To investigate whether students change their attitudes towards maths between primary and secondary school, the change in rating was calculated. Figure 1 shows that just over half the students did change their attitude, but more found primary worse than secondary.

Figure 1: Change in attitudes to maths between primary and secondary school

Maths attitudes	Freq.	%
Secondary worse	117	21%
Same	279	49%
Primary worse	172	30%
Total	568	

To assess differences in attitudes to maths by faculty, the 5-point scale was reduced to a 3-point scale and the results shown in Figure 2. As expected, Engineering had a much higher proportion of students who enjoyed maths at secondary school. However, over 40% of students in every faculty enjoyed maths, which is surprising given the number of people who claim to dislike maths in general.

Figure 2: Comparison of attitudes to maths in secondary school by faculty



It is fairly common for people in the UK to openly admit that they are bad at maths whilst very few admit to being bad at other subjects e.g. English. We used 6-point Likert questions starting with 'I did badly in …' for maths and English in primary and secondary school questions to gauge students' perception of how they did at school. Apart from a slight increase in people agreeing that they did badly in secondary school maths, the other differences were negligible.

3.2 University study and impact

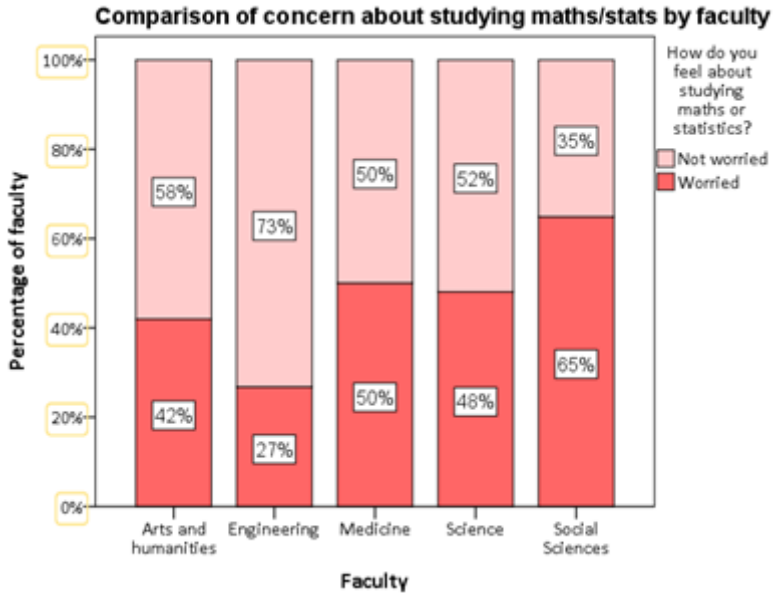
Students were asked if they expected to study maths or statistics as part of their course and 89% said they were. Figure 3 contains a further breakdown of the results.

Figure 3: Breakdown of subjects students expect to study as part of their course

Expect to study	**Number**	**Percentage**
Neither	28	5%
Just maths	158	29%
Just stats	136	25%
Both	196	36%
Don't know	32	6%
Total	550	

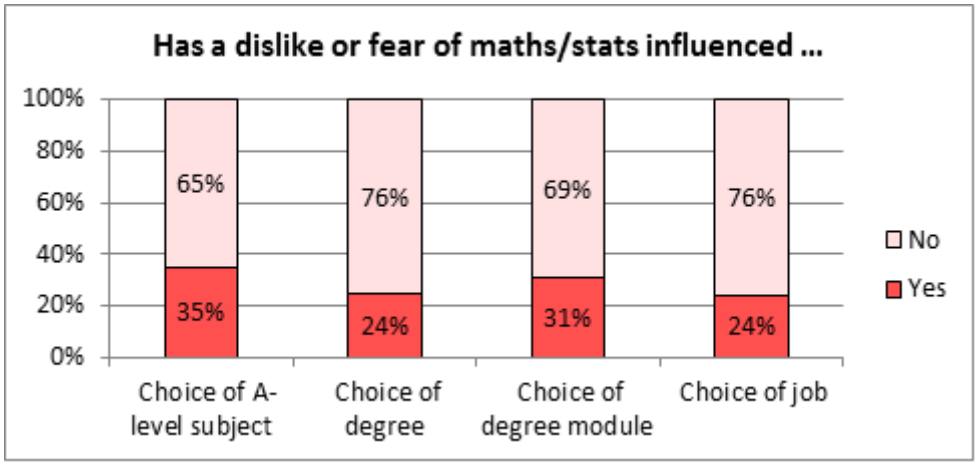
It was expected that more students would be studying statistics, but the underrepresentation of Social Sciences in the study is the likely cause. It is also possible that students don't know that they will be using statistics later in their degree so have answered "no" or "don't know". Overall, 48% of students were worried about studying maths or stats. Figure 4 shows the percentage of students within each faculty who said they were worried (either a bit or very). Students in the social sciences are the most concerned about studying maths or statistics with engineers having the lowest levels of concern.

Figure 4: Impact of anxiousness about maths on choices



Students were asked whether a fear or dislike of maths had influenced choices of A-level, degree, module or job. Overall, 44% of students said that a fear or dislike of maths had influenced at least one of these choices. Figure 5 shows the impact on each choice with A-level choice having the highest percentage of 35%. Choice of A-level limits each of the other choices so it has the biggest impact.

Figure 5: Impact of anxiousness about maths on choices



3.3 Factors linked to higher maths anxiety

This section makes comparisons between different groups on overall maths anxiety scores from the MAS-UK score. It is hard to say whether some factors led to higher maths anxiety or maths anxiety influenced outcomes or decisions. For example, students without maths qualifications above GCSE have higher maths anxiety. It is difficult, however, to determine whether anxiety prevented them from choosing further maths, or whether they are more anxious now because they do not have further maths. Also, there were strong associations between independent variables; for example, Chi-squared tests showed significant associations between faculty, gender, and further maths. A higher proportion of males have further maths qualifications (66% compared to 41% of females) and Engineering have further maths qualifications (86%) compared to Arts and Humanities (23%) and Social Science (26%).

Univariate analysis was carried out on the variables of interest to help choose variables to be included in the main ANOVA. It was suspected that UK students may have higher maths anxiety compared to others due to the negative maths culture, but when the nationality groups UK, China/Malaysia, India, and Other were compared, Chinese students had a slightly-higher mean maths anxiety score, although no significant differences were found ($F(3,483)=0.162$, $p=0.922$). It was also thought that parental attitude to helping with maths homework at secondary school would impact on maths anxiety, but although those whose parents never helped when asked had a higher mean maths anxiety score, there were no significant differences ($F(3,566)=1.655$, $p=0.176$).

We then ran a Main-Effects-Only Multiple ANOVA model with the eight independent variables shown in Figure 6 as factors, as this summarises the results of the survey.

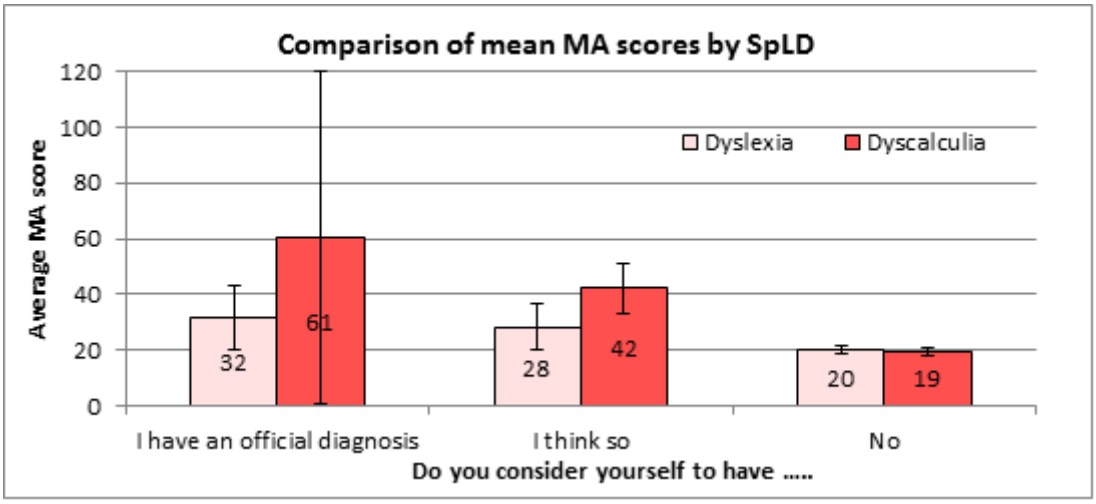
Figure 6: Multiple ANOVA results with dependent variable MA score

Independent variable	**Categories**	**Test Statistic F**	**p-value**	**Effect size Partial Eta-squared**
Gender	Males/females	2.936	0.087	.008
Parents helped with homework	yes/no	1.244	0.265	.003
Dyslexia	Official diagnosis, I think so, No	3.738	0.025	.020
Dyscalculia	Official diagnosis, I think so, No	13.877	0.000	.070
Experience of 1:1 support	Not had 1:1, positive, negative	3.404	0.034	.018
GCSE A*-C at first attempt	yes, no	5.224	0.023	.014
Maths qualification above GCSE	yes, no	41.008	0.000	.100
Faculty	A&H, Eng, Med, Sci, Social Sci.	3.193	0.013	.033
a. R Squared = .382 (Adjusted R Squared = .359)				

As Figure 6 shows, when running the full model, gender, and whether or not parents helped with homework were not significant. Gender was expected to be significant, but part of the difference is explained by gender differences between faculties and having further maths qualifications. Looking at the effect sizes, whether or not students have a maths qualification above GCSE Maths, and dyscalculia status appear to be the strongest predictors of maths anxiety. As expected, students who have or think they have a SpLD have significantly higher maths anxiety scores than those who don't. Figure 7 shows the

mean MA scores with confidence intervals for each group. It should be noted that for the group who think they have dyscalculia, they may be confusing maths anxiety with dyscalculia.

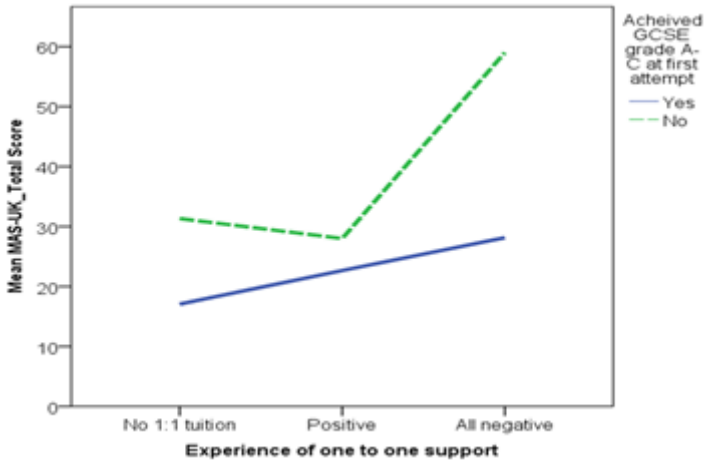
Figure 7: Impact of Specialist Learning Difference on mean maths anxiety scores (with 95% confidence intervals)



44% of students had received one-to-one support either at school or home and 80% of those students said it was a positive experience. Students receiving 1:1 support had a range of maths qualifications so as with maths support, tuition was not limited to those likely to fail. Students from China and India were much more likely to have received 1:1 support.

Figure 8 compares the mean maths anxiety score for response to the 1:1 support question grouped by whether or not the student passed GCSE maths the first time. It is clear that the combination of not passing GCSE maths at the first attempt and a negative experience of 1:1 support has the highest maths anxiety score. However, as we don't know the reasons why students did not receive 1:1 support, anxiety levels before 1:1 support or when they received 1:1 support, it is difficult to draw conclusions about the impact of 1:1 support. It may be that students who were more anxious were more likely to receive 1:1 support.

Figure 8: Relationship between passing GCSE Maths and one-to-one experience on mean maths anxiety score



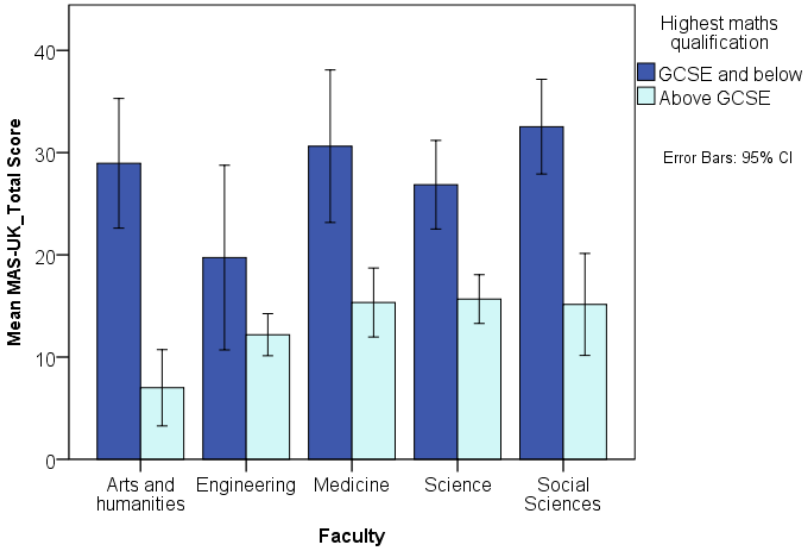
There were significant differences between most faculties for maths anxiety scores, which are summarised in the table of post hoc *p*-values (Figure 9).

Figure 9: p-values from Tukey post hoc tests for MA score and faculty

Tukey pairwise p-values	Arts and humanities	Engineering	Medicine	Science
Engineering	0.008			
Medicine	1.000	0.004		
Science	0.937	0.009	0.941	
Social Sciences	0.009	< 0.001	0.002	< 0.001

When highest maths qualification is taken into account, faculty differences become smaller, which is demonstrated in Figure 10 below.

Figure 10: Comparison of mean maths anxiety score by faculty and highest maths qualification



4. Conclusions and further work

In summary, the survey was a good starting point for investigating attitudes and anxiousness about maths, but important information is missing to draw strong conclusions about the causes of maths anxiety. We may consider carrying out a further survey with refined questions and perhaps concentrating on the impact of 1:1 support on maths anxiety.

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