Student Preferences for Online Maths and Stats Support and difference on Mathematics Anxiety

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Abstract

During the COVID-19 pandemic, many Maths and Stats Support (MSS) centres moved to offer wholly online support. By examining student preference scores to different types and deliveries of MSS, insight is gained into what forms of academic support students want going forwards. Students' mathematics anxiety levels are evaluated in three distinct situations: in general, before online support, and before in-person support. Thematic analysis of student preferences identifies the key themes for students preferring different forms of support. Factors such as accessibility and support logistics are discussed as key features in determining students preferred support method.

Keywords: Mathematics and Statistics Support, in-person support, online support, mathematics anxiety.

1. Introduction

In response to the COVID-19 pandemic many universities moved to online modes of teaching, and this included their maths and stats support (MSS) centres. These are facilities offered to students (not necessarily of mathematics) in addition to the regular programmes of teaching through lectures, seminars, tutorials, and problem-solving classes (Lawson et al., 2003). Workshops, drop-in sessions, and dedicated one-to-one appointments are currently some of the most common types of support. (Lawson et al., 2020).

As universities re-open and continue their face-to-face teaching, MSS centres must determine if they will resume face-to-face teaching, or maintain online teaching, or move to a more blended approach'. In making this decision MSS centres must consider student preferences and specifically consider that many students who are on their final year of a three-year course, will have only ever experienced online support during their degrees.

Mathematics anxiety is a negative emotional reaction to mathematics that has been defined as "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 & Suinn, 1972). Students with high levels of this situational-specific anxiety often practice mathematics avoidance (Hembree, 1990), by choosing subjects they think will not include maths or statistics. But with many more courses, particularly in social sciences, now including mandatory statistics modules, maths and stats is harder to avoid. Mathematics anxiety has also been found to be an important predictor of mathematics performance and achievement (Ashcraft & Moore, 2009) and MSS centres have observed the impact of anxiety in students for several years (Marshall et al., 2017).

To understand student's preferences for maths and stats support and to understand how levels of mathematics anxiety differ between delivery of support, three research questions were defined:

- RQ1 - Do students prefer online maths and stats support or in-person maths and stats support?

- RQ2 - Do students prefer a particular type of maths and stats support?
- RQ3 - Do students report higher levels of mathematics anxiety immediately before an online session or an in-person session?

2. Method

2.1 Participants

Mathematics and statistics support services at the University of Lincoln is delivered through the Maths and Stats Help Centre (MASH), one of the Learning Development Services based in the University Library. Before the pandemic the service offered almost exclusively in-person support and during the pandemic the service offered exclusively online support. Students seeking direct one-to-one support can book a maths or stats appointment and they are allocated an appropriate advisor. The service is staffed by specialist part-time advisors. Much of the support offered at MASH is dissertation statistics support such as helping students determine appropriate statistical tests and running statistical tests with sample data. In addition, the service offers maths support helping students learn and practice mathematical techniques such as algebra, calculus, and drug-dosage calculations.

Students who attended an online one-to-one appointment with the University of Lincoln MASH service in the 2020/2021 academic year were invited to participate in this study. Three hundred and fifty students were identified as possible participants as they provided their contact details for further work and 114 (32.6%) participated. Participation was voluntary and the project was approved by the University of Lincoln Ethics Committee. Students were invited from all years of study; this with their gender data is presented in Table 1.

Table 1. Sample demographics.

Year of Study	Gender		
	Female	Male	Total
Level 1 Undergraduate	3	1	4
Level 2 Undergraduate	10	0	10
Level 3 Undergraduate	46	4	50
Postgraduate Research	11	5	16
Postgraduate Taught	27	7	34
Total	97	17	114

The gender divide of the overall sample was significantly skewed towards females (85.1%), which is consistent with gender splits of MASH service users in previous years. The majority of participants were enrolled in Psychology (42.2%) or Clinical Animal Behaviour (14.7%), which are the two subject areas with the highest percentage of female students: 81.2% and 81.7% respectively (HESA, 2021). The remaining students come from a wide range of courses from Journalism to Computer Science with 38 different courses represented, 32 of those however are represented by single students, therefore between subject analysis was unable to be conducted.

2.2. Student Engagement

During the pandemic, the MASH centre was forced to move entirely online. Most of the student engagement with the service was through One-to-One appointments using the Microsoft Teams video call feature, with almost all participants receiving at least one hour of dedicated one-to-one support. The University of Lincoln MASH is rare in this regard as we are one of the very few centres to offer

predominantly statistical dissertation support rather than a more holistic maths and stats learning environment.

2.3 Data Collection

A mixed-methods cross-sectional design was used to measure students' preferences for different types and delivery techniques of their MSS. Students were asked to evaluate how likely they were to attend three types of mathematics and statistics support: One-to-One Appointments, Workshops, and Drop-in sessions; for online and in-person delivery; giving six preference scores for each student. Each question asked students to record their likelihood of attendance on a 7-point scale from Extremely Unlikely (1) to Extremely Likely (7). In addition to their numerical scores, students were asked to give reasons for their preferences for different deliveries and types of support. These reasons offer qualitative insight into preferences and allow for direct observation of the student voice.

Students were also asked their levels of mathematics anxiety in three situations: in general, immediately before an online session, and immediately before an in-person session. Mathematics anxiety in general was collected to use as a baseline to allow for identification if mathematics anxiety changes before MSS, where students were asked to rate their levels of mathematics anxiety without a specific situation. Mathematics anxiety was measured using a modified version of the Single-Item Math Anxiety Scale [SIMA] (Nunez-Pena et al. 2014) due to its good convergent validity, efficiency, and ease of administration. The modification was made by appending a situation to the scale's base question, e.g. "On a scale from 1 to 10, how math anxious are you, immediately before an online session?". Of the 114 students who accepted the invitation to participate, all students completed the likelihood and mathematics anxiety questions. A single scale was used for students seeking maths or stats support because many appointments covered both areas of support, e.g., support the statistics of running an ANOVA and supporting the maths of calculating and understanding the means and differences.

Mathematics anxiety scores were not collected before appointments to encourage students to seek out MASH for their support needs without any pressure or obligation to participate in this study.
Many MASH service users access the service only once, therefore it was not possible to gain a sufficient sample of student who have experienced both in-person and online support. Students who have not experienced a type or delivery of MSS were asked to imagine how they would feel in those situations. Further research is currently being conducted to explore how mathematics anxiety levels change immediately before and immediately after single MSS interactions.

2.4 Data Analysis

Descriptive statistics were used to present overall mean preference scores and overall mean mathematics anxiety scores. The 2 x 3 Repeated Measures ANOVA was used to test whether mean differences between types of support and delivery of support were statistically significant. Pairwise comparison testing allows for direct examination of the within factor effects without increasing our Type 1 error rate. The One-Way Repeated Measures ANOVA was used to test whether mean differences between mathematics anxiety scores were statistically significant. Pairwise comparison testing again allows for direct examination of specific differences between scenarios.

Thematic analysis was used to identify, analyse, and report patterns and themes within the student preference open questions. Thematic analysis is conducted in six phases: familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (Braun and Clarke, 2006).

3. Results

First, the student preference scores are analysed (Section 3.1) by way of direct analysis of means and then by two-way repeated-measures ANOVA analysis with post hoc pairwise testing. Next, analysis of mathematics anxiety scores is presented (Section 3.2) by direct analysis of means and by repeated-measures ANOVA. Finally, a thematic analysis of student responses is presented (Section 3.3) to show the two primary themes for student preference justification.

3.1 Student Preferences

Figure 1 shows the mean preference scores for different types of maths and stats support, separated by delivery technique, with error bars representing 95% confidence intervals also shown. Across all three support types, there was a greater preference for online support rather than in-person support. The largest observed difference between online and in-person support was through appointment support.
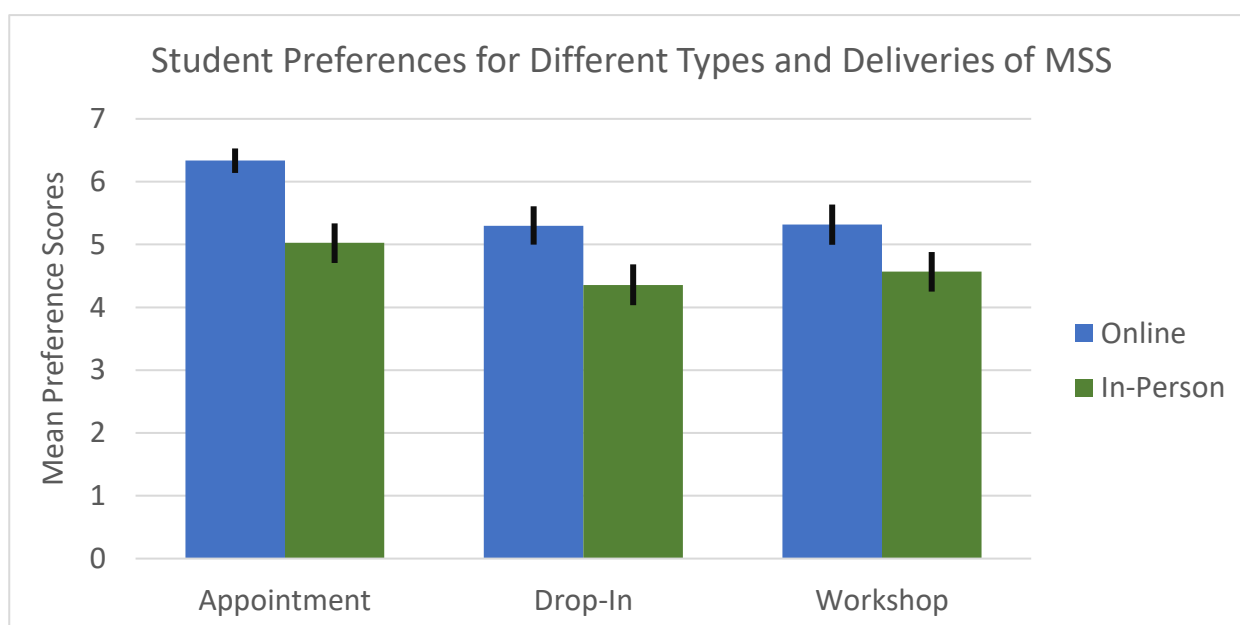

Figure 1. Student Preferences for Different Types and Deliveries of MSS.

To assess if observed differences are significant a 2 (Delivery) x 3 (Type) Repeated Measures ANOVA was conducted. There was a significant main effect for delivery of support on students' preferences ($F_{(1,112)} = 47.04$, $p < .001$, $\eta2 = .296$). Students reported a greater preference for online delivery of their maths and stats support (M=5.64, 95% CI [5.41, 5.86]) than in-person delivery of maths and stats support (M=4.65, 95% CI [4.38, 4.93]).

There was a significant main effect of type of support on students' preferences ($F_{(2,224)} = 29.58$, $p < .001$, $\eta2 = .209$). Students reported a greatest preference for One-to-One Appointments (M= 5.68, 95% CI [5.49, 5.87]), then for Drop-In support (M = 4.94, 95% CI [4.66, 5.22]) then Workshops (M = 4.82, 95% CI [4.55, 5.09]). Pairwise comparison showed that preference for One-to-One Appointments was significantly higher than both drop-in support ($p < .001$) and workshops ($p < .001$) however there was no statistical difference between drop-in support and workshops ($p > .05$).

There was also a significant interaction between delivery of support and type of support on students' preferences (F (2,224) = 7.91, p < .001, η2 = .066). The greatest preference being for online appointments (M = 6.33, 95% CI [6.13, 6.52]) and the least preference for an in-person workshop (M = 4.35, 95% CI [4.03, 4.68]). This low value may be attributed to the risks of COVID-19 transmission, however, only one participant's responses indicated that COVID was a factor in their preferences.

There were no significant differences for gender in any of the 6 preferences scores, however, due to the comparatively small sample of male students and complete lack of non-binary students, this would benefit from further analysis in a larger study.

3.2 Maths Anxiety Scores

The mean score for the sample of 114 students was 5.53 (*SD* = 2.66) with a median score of 6. This is higher than the original SIMA test sample who had a mean score of 5.18 (SD = 2.43) and a median score of 5. Figure 2 shows the mean maths anxiety scores in three situations with error bars representing 95% confidence intervals also shown.
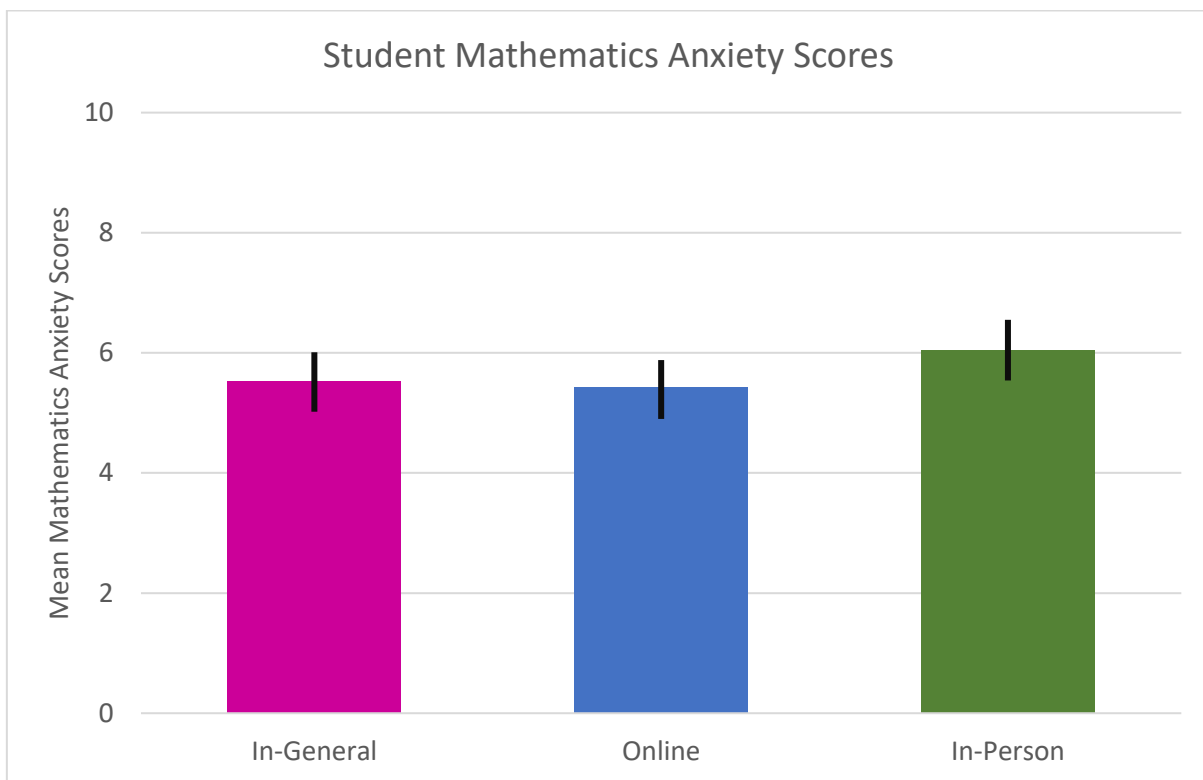

Figure 2. Student Mathematics Anxiety Scores.

To assess if observed differences are significant a One-Way Repeated Measures ANOVA was conducted. There was a significant main effect for situational mathematics anxiety (F (2,228) = 10.43, p < .001, η2= .084). Students reported experiencing the greatest levels of mathematics anxiety before an in-person session (M = 6.04, 95% CI [5.54, 6.55]); then comparable levels between mathematics anxiety in general (M = 5.51, 95% CI [5.02, 6.00]) and mathematics anxiety immediately before an online session (M = 5.39, 95% CI [4.90, 5.88]). Post hoc analysis showed that the differences between in-person and general (p=.004), and in-person and online (p < .001) were statistically significant; whilst the difference between general and online was not significant (p = .455).

3.3 Thematic Analysis

To gain a deeper insight into student motivations, participants were asked to explain their reasoning for their preference scores and 100 (87.7%) provided qualitative data. Two overarching themes, *Service Accessibility* and *Support Logistics* were identified from the students' responses. Quotations along with students' ages and genders are provided to illustrate specific sub-themes. The themes and sub-themes are summarised in Table 2.

Table 2: Themes and Sub-themes of the Thematic Analysis

Themes	Sub-themes
Service Accessibility	Travelling
	Time Commitment
	Personal Challenges / Disabilities
Support Logistics	Screen-Sharing
	Recordings
	Communication Problems

Service Accessibility

The *Service Accessibility* theme highlighted three sub-themes for student preferences: Travelling for Support, Time-Commitment and Personal Challenges including disabilities. A large number of students indicated that travelling for support was a major factor in determining which delivery of support they prefer. Many service users are off-campus students who expressed the added difficulties in travelling to campus for a single in-person session:

"…being online meant I didn't have to drive into the city…" [21F]
"I prefer online because I'm a commuting student… "- [25M]
"I'm not based on campus, online is my preference "- [32F]
"I live in Edinburgh so visiting Lincoln is a big trip"- [36M]

In addition to the travelling aspect, more students identified the time taken out of their day for support as another key factor in their preference choices.

"*Online appointments require less time out of the busy day*" [21F]
"*Online is more convenient if less time is available;
don't have to walk into university*" [21F]
"*I don't necessarily have the time to do a workshop*" [36M]

Direct accessibility was another reason given by students for a preference towards online maths and stats support delivery. Multiple students demonstrated how online support can lead to a more inclusive support centre.

"Shy/embarrassed in person. Online I can take notes easier"- [21F]

> *I get very embarrassed in person by my low ability in*
> *maths due to having dyscalculia"-[22F]*
> *"Online appointments are easily accessible;*
> *Microsoft Teams has built-in subtitles"- [22F]*
> *"...as someone who has a medical condition being able to*
> *[have online support] in the comfort of my own home was great" – [21F]*

Support Logistics

The *Support Logistics* theme highlighted three sub-themes around the practicalities of a maths and stats support session: Screen-Sharing, Recordings, and Communication Problems. A large proportion of maths and stats support in higher education is assisting students with statistical analysis for their dissertation. Through online support, students can share their screen/data which allows for more detailed support from advisers including giving examples using the students' data. This has been given by several students as their primary reason for preferring online delivery.

> *"I would be more likely to request an online appointment*
> *due to being able to have all my data there on my PC" - [21M]*
> *"Online is more convenient and is easy to follow the steps taken on SPSS*
> *when the screen is shared" - [21F]*
> *"An online appointment means the student can share*
> *exactly what they've been working on"- [22F]*
> *"I was able to work on my statistics whilst being showed*
> *and told advice directly on my screen" –[24M]*

In the recording sub-theme, students mentioned how they like the recording/playback feature of online video sessions and that group sessions can be replayed by students who have a timetable clash.

> *"I like to record via Microsoft Teams"- [29F]*
> *"Recording via Teams is great" – [29F]*
> *"[workshops] could have the possibility of being recorded so that people*
> *with conflicting timetables/jobs/childcare can attend" – [22F]*

Whilst many students prefer online maths and stats support delivery, particularly online appointments, this preference is not unanimous. There is a large proportion of students who dislike online MSS delivery due to the inherent communication problems of using video calls.

> *"It's easier to explain and show things in person as there are less barriers*
> *and physical notes are easier for me than virtual ones"- [21F]*
> *"In-person is better for me to explain myself and show what I mean,*
> *I struggle doing this online"- [22F]*
> *"I find it easier to communicate in person and there*
> *were some connection issues at times."- [22F]*

4. Discussion and Conclusion

This case study investigated what type and delivery of maths and stats support students prefer, reasons for their preferences, and how different deliveries of maths and stats support impact mathematics anxiety. We were looking for students' views on the advantages and disadvantages of different types of support and where those features impact the likelihood to attend support sessions.

Further, we looked for differences in mathematics anxiety levels considering different deliveries of MSS.

The results of the student preference questions indicate that for students in our sample there is a significant preference for online support over in-person support and a preference for tailored one-on-one sessions over group sessions, such as drop-ins and workshops. As each MSS centre caters for different types of students with different needs and expectations, this result will likely differ between centres.

Taking students' levels of mathematics anxiety in general as a baseline, students report no significant changes before receiving online support, however, they report a significant increase in their mathematics anxiety levels before in-person support. One reason for this, given by a student, is that they feel more nervous in person as they so don't want to be embarrassed. With students receiving the same support from the same people it is very concerning that purely being in-person raises their levels of mathematics anxiety, given its associations with maths avoidance and poorer maths performance. Mathematics anxiety scores before online support are similar to mathematics anxiety in general, therefore we can conclude that attending MSS does not itself raise anxiety scores, they are only raised when attending in-person MSS. To protect students who may be at risk from suffering the worst symptoms of mathematics anxiety, which can include physical pain, MSS centres must ensure they continue to offer some forms of online support.

The study also gave insight into how students determine which type of support they prefer with accessibility and support logistics being the two overriding themes. While there were many advantages to online support such as convenience, ease of use, and recording features, the inherent communication problems should not be ignored. These mixed preferences from students, with an overall preference towards online support, show that students have appreciated the move to online support during the COVID-19 pandemic and provide recommendations across academic and professional service support.

The delivery of support should be matched to the type of support required. Students needing advanced mathematics support, such as vector mathematics or linear algebra, are more likely to benefit from in-person support where problems can be solved together, and the advanced and often contradictory notation can be demonstrated more easily. In contrast students needing guidance on choosing appropriate statistical testing benefit from a more relaxed and open conversation around statistical research that can be conducted through online support.

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