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RESEARCH ARTICLE

Are students too anxious for statistics anxiety workshops?

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Abstract

Statistics is a widely taught subject in Higher Education but for many students, anxiety about statistics interferes with the learning process. Statistics anxiety workshops to help students understand and reduce statistics anxiety were developed by the authors and in 2020/21 delivered collaboratively and remotely with specific cohorts of students at three institutions. Prior to the workshops, all students within the targeted cohorts were asked to complete a survey which included measures of statistics anxiety, and asked if they were interested in attending the voluntary workshop. This enabled a comparison of the characteristics of groups who were interested or not. The workshops successfully attracted the targeted students, since those attending had higher overall statistics anxiety, software and maths anxiety, and anxiety around learning statistics. However, students with higher help seeking anxiety were less likely to attend.

Keywords: statistics anxiety, higher education, workshop, attendance.

1. Introduction

Statistics anxiety is a situation-specific anxiety which can have a considerable impact on a student's ability to study statistics effectively. It is thought that between 70% and 90% of students have some level of statistics anxiety (Zeidner, 1991; Marshall et al, 2021). Whilst several studies show links between statistics anxiety and performance (Onwuegbuzie et al, 2000; Paechter et al, 2017; Zeidner, 1991), it is more likely this is an indirect effect with anxiety, attitudes and motivational beliefs impacting on learning behaviour and subsequently performance. Anxious students often try to avoid situations that involve engagement with statistics, including attending lectures and asking for help. They are more likely to delay work until just before a deadline, have less perseverance at tasks, and put little effort into learning (Macher et al, 2011). This leads to poorer performance (Macher et al, 2011; Gonzalez, 2016; Macher et al, 2013; Kesici, 2011), reinforcing their view that they cannot learn statistics.

Research into maths and statistics anxiety tends to focus on understanding why students are anxious rather than strategies for reducing anxiety but Johnston-Wilder et al, 2016; Johnston-Wilder and Marshall 2017 identified a two-stage process for reduction of maths anxiety. The first stage involves awareness of maths anxiety and developing approaches to overcome triggers followed by the provision of positive teaching experiences. One of the most effective methods for reducing maths anxiety is receiving positive one-to-one support (Núñez-Peña et al. 2015; Johnston-Wilder and Marshall 2017), as support is tailored to the individual and allows immediate feedback. However, as anxious students may try to avoid mathematical situations, many anxious students do not engage with this additional support. A study by O'Sullivan et al, (2014) estimated 33% of students who are at risk of failing do not seek appropriate support, often citing anxiety as the reason for not doing so.

Marshall et al, (2017a) trialled a whole cohort group psycho-educational maths anxiety workshop embedded within a foundation maths course, and found that the workshop had an immediate reduction in maths anxiety in the cohort. However, when the workshop was trialled as an optional University-wide session, attendance was poor and those attending were mostly from disciplines requiring a higher level of maths such as economics or engineering. Research incorporated into the workshop included the impact of anxiety on the brain and learning, reflection on past experiences with maths, addressing negative beliefs, growth mindset (Johnston-Wilder et al, 2015) and learning strategies. One of the first stages for a student to overcome anxiety is to understand what it is and how it affects their learning (Uusimaki & Kidman, 2004). It is also important for students to share past experiences which may have contributed to their anxiety, such as negative experiences with maths, and realising that others feel anxious (Marshall et al, 2017a).

Hood & Neumann, (2013) used a similar workshop for statistics anxiety which included discussion of concerns about statistics, use of basic statistics within the session, and learning styles. Comparison of those who did and did not attend the voluntary workshop at the end of term showed that amongst attendees, there was an increase in self-efficacy and worth of statistics, and a decrease in fear of statistics teachers. No changes in self-efficacy or worth of statistics were observed amongst non-attendees. However, a drop in statistics anxiety was observed in both attendees and non-attendees, making it harder to distinguish the impact of the workshop from instructional style.

Online learning has meant that facilitators can co-deliver teaching to students from multiple institutions simultaneously, without any restrictions on geographical location. Therefore, the statistics anxiety workshops that this current study reports on were delivered jointly by presenters at UK and Australian institutions in the academic year 2020/2021. While the authors viewed the multi-institution aspect of the workshop as a positive, we acknowledge that students may not have. Students could infer from the registration form that there would be students from other universities attending the session and this could have been a barrier to them attending the workshop.

The statistics anxiety workshop was adapted from the existing maths anxiety workshop developed by Marshall et al, (2017a, 2017b), but incorporated more of the strategies used by statistics support services for addressing anxiety (Johnston-Wilder and Marshall 2017). These strategies include seeking help when needed, peer learning, persistence and recognising progression. An important addition was the framing of the strategies within a case study of a very anxious student who attended statistics support, and was able to overcome statistics anxiety and complete her quantitative research. The aims of the workshop were to increase awareness of statistics anxiety and its impact on learning, and to suggest strategies for students that address their anxiety about statistics. Shorter versions of the self-help resources created by the authors can be freely accessed on the Sheffield Hallam maths and statistics support service (<https://maths.shu.ac.uk/mathshelp/Anxious.html>). Prior to the main offerings of the workshop reported on in this study, a pilot statistics anxiety workshop was trialled by the researchers at the University of York in February 2020. Despite low attendance, reflections on this face to face session informed the workshop presented here. Further adaptations of the workshop were necessary as it had to be delivered online due to the Covid-19 pandemic. These included asking attendees to answer questions or contribute to discussions in the chat function, and facilitating small group discussions in break out rooms where everyone could contribute to a shared online document. This document summarised the main points discussed in the small groups for everyone to view.

Three specific cohorts were offered the opportunity to attend the optional extra curricular workshop. The cohorts targeted for the intervention were surveyed before and immediately after the workshop, as well as at the end of the year. This paper focuses on identifying whether anxious students are interested in and engage with voluntary statistics anxiety workshops using the pre-workshop survey data.

2. Methods

The pre-workshop survey was sent to first year Psychology students at Sheffield Hallam University (SHU) and the University of Worcester, and second year Biology students at La Trobe University. The survey included scales measuring statistics anxiety, worry or concern about learning statistics, maths anxiety, and interest and value in learning statistics and associated measures. Students were also asked if they were interested in attending a statistics anxiety workshop (see below), and demographic questions such as gender. Scales measuring different dimensions of statistics anxiety were taken or adapted from the Statistical Anxiety Measure - SAM (Earp, 2007), and Statistical Anxiety Rating Scale - STARS (Cruise, Cash and Bolton, 1985; see Appendix for items and Cronbach's alpha for each subscale). Seven-point scales for all anxiety questions were used, with responses ranging from "not at all anxious" to "extremely anxious". Items from the SAM scale representing worry or concern about learning statistics were also used (Cronbach's = 0.841). Maths anxiety was measured using three items from the sources of self-efficacy in maths scale (Usher & Pajares, 2009), on a 9 point scale (Cronbach's = 0.931). Items from subscales of the Motivated Learning Strategies Questionnaire - MLSQ (Pintrich, 1991) were used to measure interest in learning, value of statistics, help seeking, statistics self-efficacy, control of learning and peer learning, all on a seven-point scale ranging from "strongly disagree" to "strongly agree".

Additionally, students' level of interest in attending a workshop was sought. Students initially answered a question in the pre survey, stating their level of interest in a statistics anxiety workshop as "yes", "no", or "maybe". For the UK cohorts (SHU and Worcester), students were then asked to register for the workshop in a separate communication. For the Australian cohort (La Trobe), students were invited to register interest using a poll administered via the Learning Management System (LMS). Students could indicate either "Yes" or "Maybe". For all cohorts, attendance was taken at the workshop and defined as a student who was present halfway through the session, although some students may have left early or arrived later. All students were also asked in the post survey whether they had attended a workshop. Interest was therefore classified as follows. If students attended the workshop, expressed interest via the pre survey or LMS poll, or registered for the workshop, they were recorded as "Yes". Students who answered "Maybe" or "No" in the pre survey or LMS poll were recorded as such. If students did not respond to the pre survey question on whether they were interested in the workshop, did not register or complete the LMS poll, did not attend the workshop, and did not fill in the end of year survey, their interest in the workshop could not be determined and they were recorded as missing for level of interest.

A total of 191 students from SHU (141), La Trobe (32) and Worcester (18) took the pre survey, although La Trobe were not asked about maths anxiety, interest in learning statistics and expectations of their statistics course, and therefore were excluded from some analyses. Directly following the workshop, students were asked to fill in the post survey, which included questions asking for workshop feedback. At the end of their academic year, all students were invited to fill in another questionnaire asking whether they had attended the workshop and if not, what the reasons were. The questionnaire also invited workshop feedback. 67 students took the end of year survey, with 24 of these also completing both pre and post surveys.

During the workshops, attendance was taken at several time points and full attendance was defined as a student who was present halfway through the session, otherwise they were categorised as leaving early. As students had cameras and microphones switched off, we acknowledge that some students may not have actually been engaged but merely logged on to the virtual classroom.

3. Results

3.1. Who is interested?

When asked, most students showed some level of interest in attending a workshop on statistics anxiety, particularly Psychology students (Figure 1).

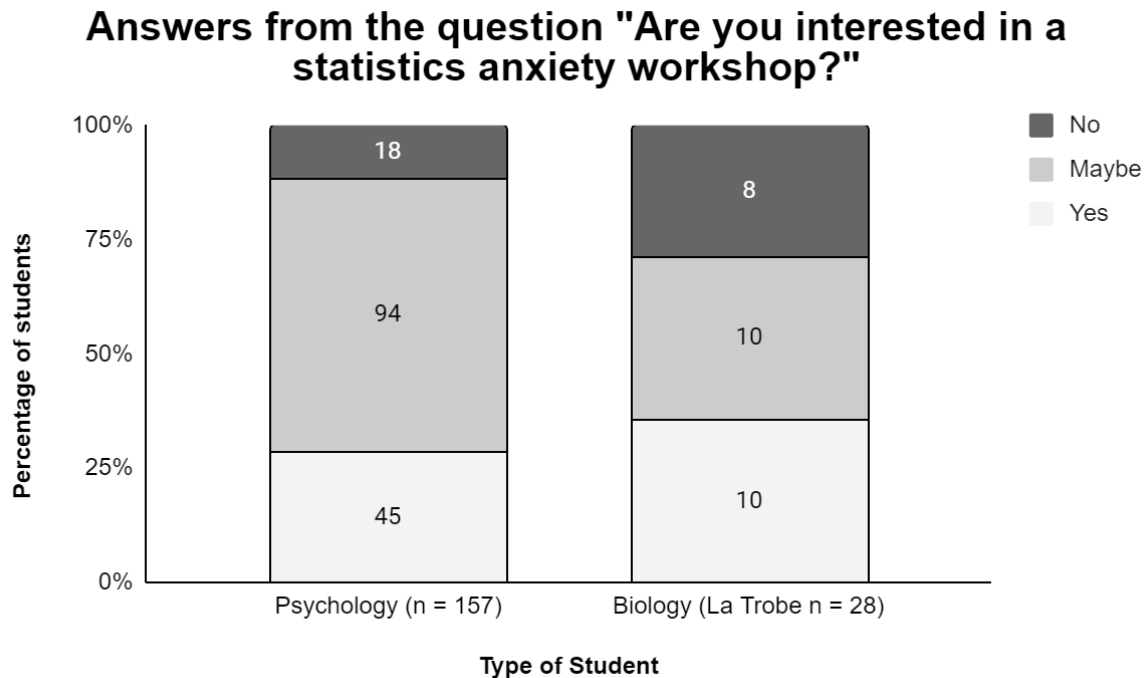


Figure 1: Percentages of students interested in a statistics anxiety workshop

For the UK workshops, 35 (22%) of the students taking the pre survey completed the initial registration form. However, only 16 students went on to choose a workshop date and only 8 actually attended. 47% of the UK students who said "Yes" they were interested, registered. Only 13% of the "Maybe" group and none of the students from the "No" group, registered.

1.3. Are anxious students interested in anxiety workshops?

Inferential statistics were used to test how anxiety differed in students with different levels of interest and engagement in the statistics workshop. To do this, students from all universities were put into five interest categories: those who attended; those who registered to attend in the separate communication or LMS poll but did not; those who said in the pre survey yes they were interested; maybe they were interested; or no they were not interested. The last three categories did not register for or attend the workshop. One-way ANOVAs were used to test the differences among these five groups with a separate one-way ANOVA used for each of the different types of stats anxiety, maths anxiety, concerns and interest measurements.

There were significant differences among the five levels of interest in the workshop for statistics anxiety as measured using the SAM scale (ANOVA, $F = 7$, $p < 0.001$; Figure 2). While there were no significant differences among those who attended, registered but didn't attend and those who said yes they were interested, these three groups all have significantly higher levels of statistics task anxiety than students in the not interested group. Despite the not interested group having the lowest average anxiety, there were still students with moderate to high anxiety in this group.

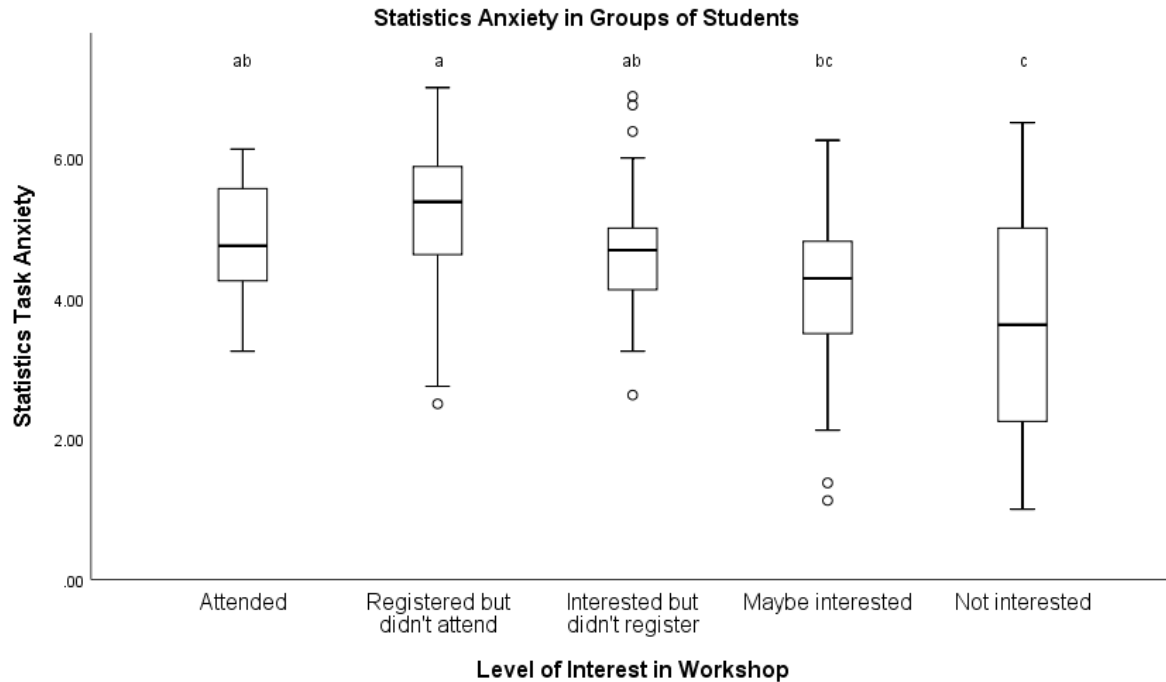


Figure 2: Statistics task anxiety measured using all items of the Statistics Anxiety Measure (SAM) scale, for students with different levels of interest in a statistics anxiety workshop. Groups that share letters are not significantly different from each other.

There were significant differences among the five interest groups for software anxiety (ANOVA, $F = 4.5$, $p = 0.002$) but not for help seeking anxiety (ANOVA, $F = 0.8$, $p = 0.525$). Students who were in the “not interested in the workshop” group, had significantly lower levels of software anxiety than those who attended, registered or were interested in the workshop. There were no significant differences among these latter three groups (Figure 3). Whilst the cohorts were generally consistent, help seeking anxiety was highest for those who were not interested in the workshop for UK students but for La Trobe, it was the group who said they were interested but didn’t register (data not shown).

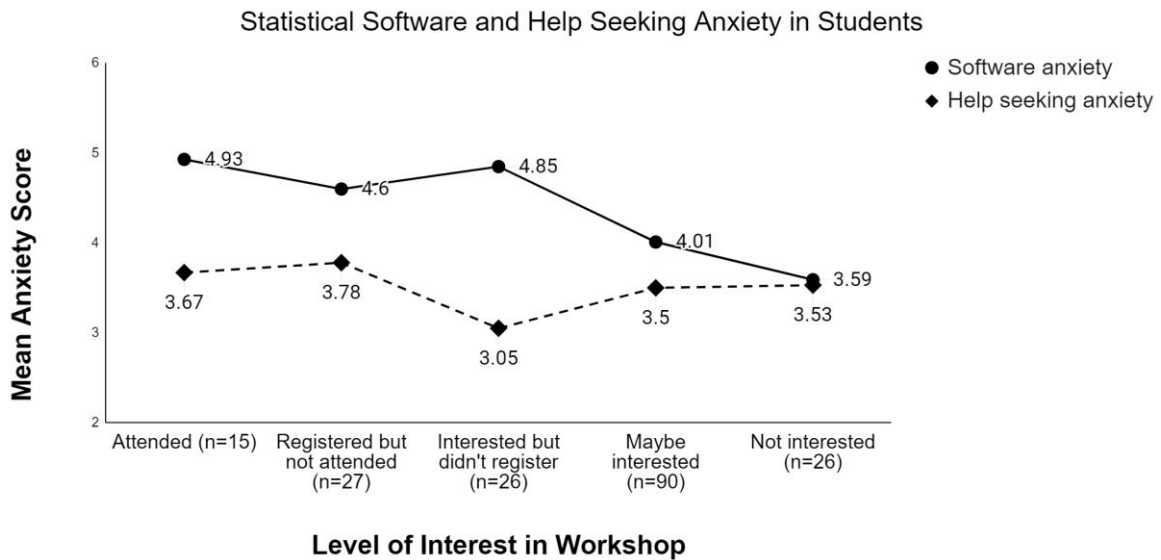


Figure 3: Mean statistics software anxiety and help seeking anxiety by interest in workshop group

To further investigate the characteristics of those who are interested in this type of workshop, groups were tested for differences in other types of anxiety for the UK students only. There were no significant differences for anxiety surrounding working with fellow students online, online lecture and tutorial anxiety, control of learning or employability (ANOVA, $F = 0.35$, $p = 0.85$, $F = 0.68$, $p = 0.60$, $F = 0.83$, $p = 0.51$, $F = 0.83$, $p = 0.51$ respectively). There were also no significant differences in interest in learning statistics (ANOVA, $F = 0.97$, $p = 0.425$), however, those who attended had the highest mean level of interest in learning statistics compared to all other groups (Figure 4). Maths anxiety (ANOVA, $F = 6.14$, $p < 0.001$) and concern about learning statistics (ANOVA, $F = 11.1$, $p < 0.001$) was significantly higher for both the students who registered but didn't attend group and the group who said they were interested but didn't register, compared to those who said they were maybe or not interested in the workshop (Figure 4). While not statistically significant, the students who ended up attending the workshop had on average lower levels of maths anxiety and concern about learning statistics, than those who only registered to attend or said they were interested but didn't actually attend the workshop (Figure 4).

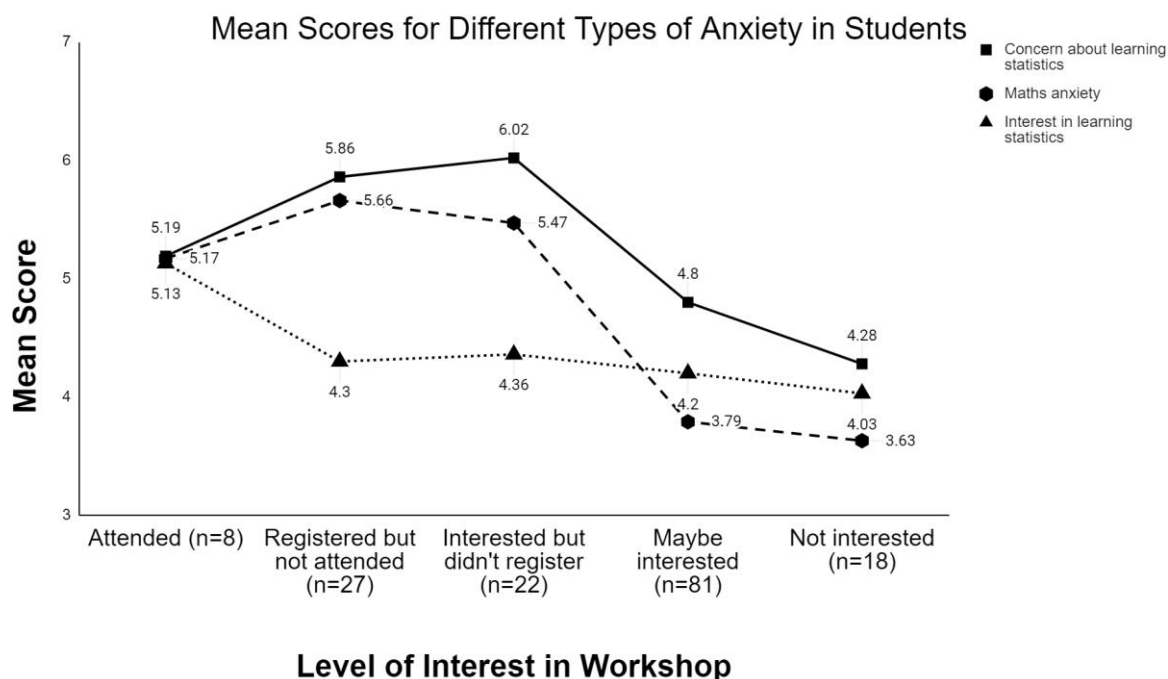


Figure 4: Mean scores for maths anxiety, interest in statistics and worry over learning statistics by workshop interest. Data for UK cohort only. Note that maths anxiety is measured on a 9 point scale whereas all others are on a 7 point scale.

To better understand the type of student who is interested in a workshop, students were reclassified as either interested (attended, registered but didn't attend, interested but didn't register) or not (maybe interested, not interested). Then backward logistic regression was used with interested or not as the binary dependent variable, and the various anxiety measurements as independent variables to identify the more important predictors. The final model, shown in Table 1, shows that those with higher levels of statistics task anxiety, interest in learning statistics, maths anxiety and concern about learning statistics were more likely to be interested in a statistics anxiety workshop. The odds of a student being interested in the workshop are multiplied by 1.9 for each additional point on the statistics task anxiety scale and doubled for concern about learning statistics. Help seeking anxiety has a negative impact after controlling for the other factors, suggesting that if a student's anxiety about statistics is more about a fear of asking for help than maths or interpretation, they are less likely to attend.

Table 1: Final logistic regression model. Response variable is "interested" (attended, registered but didn't attend, interested but didn't register) in workshop or "not" (maybe interested, not interested).

| Final backwards logistic regression model | B | P-value | Odds ratio |
|---|-------|---------|------------|
| Statistics task anxiety | 0.645 | 0.026 | 1.9 |
| Interest in learning statistics | 0.397 | 0.021 | 1.5 |

| | | | |
|-----------------------------------|--------|-------|-----|
| Maths anxiety | 0.212 | 0.08 | 1.2 |
| Concern about learning statistics | 0.673 | 0.003 | 2.0 |
| Help seeking anxiety | -0.438 | 0.01 | 0.6 |

The final model correctly predicts 59% of those who were at least interested and 91% of those who were either not or maybe interested. A model that correctly predicts a higher proportion of those interested also contains measures of how relevant students feel statistics is and whether they feel success is related to the effort they put in. Students who do not value the learning of statistics and don't believe they can learn statistics even if they try, are less likely to say they are interested.

1.4. Reasons for not attending

55 students from the UK and La Trobe filled in a multiple choice question in the end of term survey to indicate why they did not attend the workshop. The most commonly chosen option was being too anxious (35%), followed by not knowing about the workshop (24%), and not being interested in the workshop or not anxious about statistics (24%). Some students chose the option that the time of the workshop was not convenient (18%) [Figure 5].

Reasons Students Chose For Not Attending a Statistics Anxiety Workshop

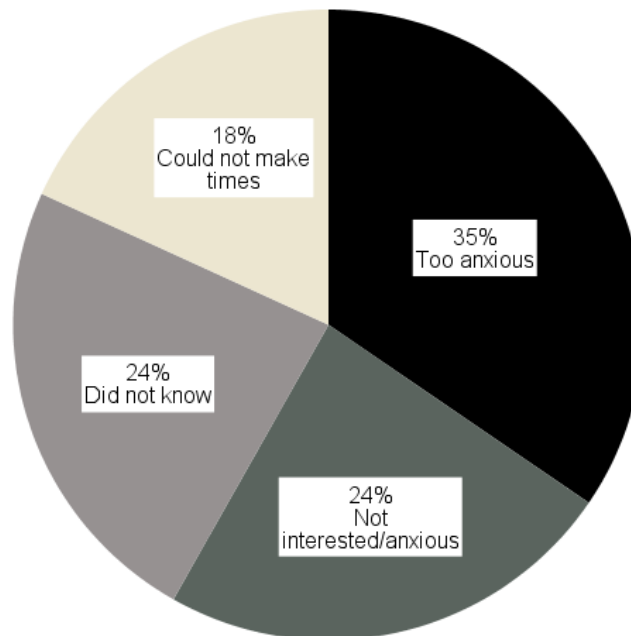


Figure 5: Reasons students chose in the end of year survey for not attending the statistics anxiety workshop.

4. Discussion and Concluding Remarks

In summary, the statistics anxiety workshops are attracting target groups with high statistics task anxiety, software anxiety, maths anxiety and those with concerns about learning statistics. These students are often motivated by interest in learning statistics although it is unclear whether this tends towards intrinsic or extrinsic. The most obvious group the workshops typically failed to attract was the group with high help seeking anxiety. Ironically, this is a group that may greatly benefit from attending the workshop because it has been observed that help seeking anxiety is negatively associated with student performance (Shaker et al, 2021). Initiatives to target this group will therefore need to be researched and take account of their intrinsic/extrinsic motivation for learning the material, since this will impact on the support approach used by staff. In addition, the student's perceived barriers to seeking out and accessing support will need to be determined.

More broadly, findings indicate that strategies in the curriculum to normalise help seeking would be of benefit to students. Attempts in universities to improve help seeking in students include PAL (Peer Assisted Learning; Hager, 2018); a university wide support structure that was scaffolded (Devine et al, 2021) and running convenient sessions where both teaching and learning support staff are available (Hammond et al, 2015). All these initiatives make it easier to access help in the practical sense. However there are few reported attempts to change the overall cultural attitude towards help-seeking for mathematics or statistics support specifically, though some wider initiatives to scaffold student self-reflection on their approach to learning in Higher Education which include seeking support from others have been developed (Coughlin et al, 2011).

Reasons given by students for not attending the workshop suggest that they did not know about it. Other students said the times of the workshop were not convenient. It could be that advertising more widely, as well as offering more workshops at a variety of times could address this issue. In terms of resourcing, it may be more practical for higher education institutions to offer statistics anxiety workshops as part of a timetabled lecture embedded into the course. As students would be familiar with staff, setting and approach, this would also compliment the workshop content on being comfortable asking for help when needed, so delivering workshops in this way may allow those who are anxious about asking for help to benefit. However, using lecture time in this way can be frustrating for those students who feel they are not anxious about statistics. Alternatively, initiatives to normalise help seeking such as - having academics signpost towards specialist staff and/or peer-support; self-help materials which engage students in study skills but which also address their expectations of the learning process, as well as showing that academics also use the services of skills centres - could be valuable.

Furthermore, the challenge of making help-seeking the norm may be more difficult at some universities than others. Preliminary data from a related project found that the students in a university with higher entry requirements were less likely to seek help compared to a university that required lower grades. While not causal, it is possible that students who are higher achieving may need to address barriers which differ in form and extent before seeking support.

This study suggests then that solutions to addressing the problem of getting students to ask for help when they need it may be in-part drawn from the students' own motivations, needs and expectations, but also influenced by the course design and perceived culture of a higher

education institution. Given that organisational culture may be difficult to define, may vary across faculty/discipline and will be difficult to influence in the shorter-term, it is suggested that practical amendments to course design and support, as well as supporting students to explore their approach to their studies, may be the most effective approach in the first instance.

5. Appendix

The items used for each statistics anxiety subscale are given below with Cronbach's alpha.

| Individual items | Cronbach's alpha (pre survey) |
|---|-------------------------------|
| <u>Online learning</u> | |
| Watching pre-recorded videos of statistics content | |
| Attending an online statistics lecture | |
| Attending an online statistics tutorial | |
| Working with fellow students in an online class | |
| Online class anxiety MEAN | 0.807 |
| | |
| <u>Face to face learning</u> | |
| Being in a statistics lecture in person on campus | |
| Attending a statistics tutorial in person on campus | |
| Working with fellow students in a face to face statistics class | |
| Face to face anxiety MEAN | 0.85 |
| | |
| | |
| <u>Statistical anxiety measure (Earp, 2007)</u> | |
| Sitting an exam in person on campus | |
| Studying statistics generally | |
| Reading statistical studies | |
| Calculating probabilities | |
| Formulating and testing hypotheses | |
| Developing conclusions based on mathematical solutions | |
| Interpreting statistics | |
| Explaining your statistical findings | |

| | |
|--|-------|
| Mean Statistics task anxiety (doing statistics) | 0.917 |
| | |
| <u>Software anxiety</u> | |
| Inputting/manipulating data in statistical software | |
| Using statistical software to carry out analyses | |
| Summarising results from the statistical software output | |
| Statistical software anxiety (mean) | 0.911 |
| | |
| <u>Fear of asking for help</u> | |
| Going to my statistics lecturer for individual help with material I am having difficulty understanding | |
| Asking a statistics lecturer for help understanding computer output | |
| Asking a fellow student for help in understanding statistics material | |
| Anxiety about asking for help (mean) | 0.889 |

6. References

Coughlin, A., Small, T., Thompson, J. and Williamson, K. J., 2011. A Guide to Understanding Learning Power with the Effective Lifelong Learning Inventory - ELLI. *Advance HE (advance-he.ac.uk)* Available at: <https://www.advance-he.ac.uk/knowledge-hub/guide-understanding-learning-power-effective-lifelong-learning-inventory-elli> [Accessed 2 February 2022]

Cruise, R. J., Cash, R. W. and Bolton, D. L., 1985. Development and validation of an instrument to measure statistical anxiety. *American Statistical Association Proceedings of the Section on Statistical Education* 4(3), pp.92-97.

Devine, C., Wilson, T. and Moody, H., 2021. [Expert] Guide on the Side: One University's Response to Support for Learning in STEM-Based Disciplines. *Student Support Services*, pp.1-13. https://doi.org/10.1007/978-981-13-3364-4_16-1

Earp, M. S., 2007. *Development and validation of the Statistics Anxiety Measure*. Ph. D. University of Denver.

González, A., Rodríguez, Y., Faílde, J.M. and Carrera, M.V., 2016. Anxiety in the statistics class: Structural relations with self-concept, intrinsic value, and engagement in two samples of undergraduates. *Learning and Individual Differences*, 45, pp.214-221. <https://doi.org/10.1016/j.lindif.2015.12.019>

Hager, A. E., 2018. *How Does Peer-assisted Learning Effect Math Anxiety, Help-seeking Behavior, and Performance in Undergraduate Mathematics?* Ph. D. Plymouth State University.

Hammond, K., Thorogood, J., Jenkins, A., & Faaiuso, D., 2015. A friendly destination: normalising first-year science student help-seeking through an academic literacy. Targeted Learning Session-a practice report. *The International Journal of the First Year in Higher Education*, 6(1), pp. 179-185.

- Hood, M. and Neumann, D., 2013. Evaluation of a workshop to reduce negative perceptions of statistics in undergraduate psychology students. *Psychology Learning and Teaching*, 12(2). <https://doi.org/10.2304/plat.2013.12.2.115>
- Johnston-Wilder, S., Lee, C., Brindley, J. and Garton, E., 2015. Developing peer coaching for mathematical resilience in post-16 students who are encountering mathematics in other subjects. In: Iceri2015, *8th International Conference of Education, Research and Innovation*. Seville, Spain. 16 - 18 November 2015.
- Johnston-Wilder, S., Pardoe, S., Almehrz, B., Marsh, J. and Richards, S., 2016. Developing teaching for mathematical resilience in further education. In: Iceri2016, *9th International Conference of Education, Research and Innovation*. Seville, Spain. 14 - 16 November 2016. <https://doi.org/10.21125/iceri.2016.1652>
- Johnston-Wilder, S. and Marshall, E., 2017. Overcoming affective barriers to mathematical learning in practice. In: IMA and CETL-MSOR 2017, *Mathematics Education beyond 16: Pathways and Transitions*, 10-12 July 2017, Birmingham, UK.
- Kesici, Ş., Baloğlu, M. and Deniz, M.E., 2011. Self-regulated learning strategies in relation with statistics anxiety. *Learning and Individual Differences*, 21(4), pp.472-477. <https://doi.org/10.1016/j.lindif.2011.02.006>
- Macher, D., Paechter, M., Papousek, I. and Ruggeri, K., 2011. Statistics anxiety, trait anxiety, learning behavior, and academic performance. *European journal of psychology of education*, 27(4), pp.483-498. <https://doi.org/10.1007/s10212-011-0090-5>
- Macher, D., Paechter, M., Papousek, I., Ruggeri, K., Freudenthaler, H.H. and Arendasy, M., 2013. Statistics anxiety, state anxiety during an examination, and academic achievement. *British Journal of Educational Psychology*, 83(4), pp.535–549. <https://doi.org/10.1111/j.2044-8279.2012.02081.x>
- Marshall, E.M., Wilson, D.A. and Mann, V.E., 2017a. Evaluating the effectiveness of maths anxiety awareness workshops. *Journal of Learning Development in Higher Education*. Available at: [https://maths.shu.ac.uk/mathshelp/Stats%20support%20resources/Maths%20anxiety/Publications/Marshall,Wilson,Mann,\(2017\)Awareness_workshop_evaluation.pdf](https://maths.shu.ac.uk/mathshelp/Stats%20support%20resources/Maths%20anxiety/Publications/Marshall,Wilson,Mann,(2017)Awareness_workshop_evaluation.pdf) [Accessed 24 September 2021]
- Marshall, E.M., Staddon, R.V., Wilson, D.A., and Mann, V.E., 2017b. 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>
- Marshall, E.M., Rowlett, P., Verrier, D. and Hunt, T., 2021. Can pre-course anxiety and attitudes predict grade? In: MERI research symposium proceedings 2021, pp 30-31, *MERI Research Symposium*. Sheffield, UK. 8 - 9 June 2021.
- Núñez-Peña, M.I., Bono, R. and Suárez-Pellicioni, M., 2015. Feedback on students' performance: A possible way of reducing the negative effect of math anxiety in higher education. *International Journal of Educational Research*, 70, pp.80-87. <https://doi.org/10.1016/j.ijer.2015.02.005>
- Onwuegbuzie, A.J., 2000. Statistics anxiety and the role of self-perceptions. *The Journal of Educational Research*, 93(5), pp.323-330. <https://doi.org/10.1080/1356251032000052447>
- Onwuegbuzie, A.J. and Wilson, V.A., 2003. Statistics Anxiety: Nature, etiology, antecedents, effects, and treatments--a comprehensive review of the literature. *Teaching in higher education*, 8(2), pp.195-209. <https://doi.org/10.1080/1356251032000052447>

- O'Sullivan, C., Mac an Bhaird, C., Fitzmaurice, O. and Ni Fhlionn, E., 2014. An Irish Mathematics Learning Support Network (IMLSN) Report on Student Evaluation of Mathematics Learning Support: Insights from a large scale multi-institutional survey. Available at: <http://doras.dcu.ie/22489/1/IMLSN-2014.pdf> [Accessed 24 September 2021]
- Paechter, M., Macher, D., Martskvishvili, K., Wimmer, S. and Papousek, I., 2017. Mathematics anxiety and statistics anxiety. Shared but also unshared components and antagonistic contributions to performance in statistics. *Frontiers in Psychology*, 8, pp.1196. <https://doi.org/10.3389/fpsyg.2017.01196>
- Pintrich, P. R., Smith, D. A., Garcia, T., and McKeachie, W. J., 1991. *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. Ann Arbor, Michigan: The Regents of the University of Michigan.
- Shaker, A.J., Hurst, P.S. and Marshall, E.M., 2021. The effect of Kahoot on undergraduate student anxiety and confidence when studying statistics. *MSOR Connections*, 19(2), pp.41-54. <https://doi.org/10.21100/msor.v19i2.1245>
- Usher, E.L. and Pajares, F., 2009. Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology*, 34(1), pp.89-101. <https://doi.org/10.1016/j.cedpsych.2008.09.002>
- Uusimaki, L. S. and Kidman, G. C., 2004. Reducing maths-anxiety: Results from an online anxiety survey. In: *Proceedings of the Australian Association for Research in Education International Education Research Conference* (pp. 1-9). Australian Association for Research in Education. Available at: <http://eprints.qut.edu.au/974/1/kid04997.pdf> [Accessed 24 September 2021].
- Zeidner, M., 1991. Statistics and mathematics anxiety in social science students: Some interesting parallels. *British Journal of Educational Psychology*, 61(3), pp.319-328. <https://doi.org/10.1111/j.2044-8279.1991.tb00989.x>