Institution: York St John University

Unit of Assessment: UoA 21 Sociology

Title of case study: Improving the statistical skill base of UK sociology through a Layered Pedagogical Model

Period when the underpinning research was undertaken: 2018 - 2019

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Kevin Ralston	Lecturer in Sociology and Criminology	September 2017 – March 2020

Period when the claimed impact occurred: 2019 - present

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Ralston's research on the sources and effects of statistical anxiety amongst social science – and particularly sociology – students has developed an applied approach to teaching quantitative methods called the 'Layered Pedagogical Model'. The model is particularly useful for refining how students from non-mathematical educational backgrounds are taught. Specifically, the pedagogical model demonstrates how teaching delivery can integrate techniques that are not related to the core statistical content into quantitative methods courses. Using such techniques – such as student self-reflection on the 'usefulness' and 'relevance' of statistical methods to sociological understanding and open discussion about students' preconceptions and anxieties concerning 'numbers' – has changed quantitative methods teaching and learning in Secondary, Further and Higher education nationally and also internationally.

2. Underpinning research (indicative maximum 500 words)

Statistics anxiety is widely reported as a major barrier in the learning-teaching of quantitative methods. However, the social, educational and psychological complexity behind 'statistical anxiety' is a greatly under-researched area. This gap in knowledge is itself a barrier to designing pedagogical practices that could improve learning outcomes through accounting for the complex processes underpinning statistical anxiety.

Ralston's research has filled this gap, focusing particularly on sociology students **[3.1; 3.2]**. On the one hand, Ralston has examined the role played by the reticence expressed by sociology students towards the legitimacy of statistical methods ('epistemological anxiety') in inducing 'statistical anxiety' **[3.1]**. A proportion of UK sociology students do not accept that statistics are legitimate in researching the social world, and this group are more likely to report experiencing statistical anxiety. Ralston's findings indicate that 'epistemological anxiety' is an important antecedent to statistics anxiety among sociology students, and that this could be addressed by designing pedagogical approaches that focus as much on acknowledging and dissipating 'epistemological anxiety' as they do on teaching the statistical methods themselves.

On the other hand, Ralston's research has challenged some previously held assumptions about the effects of gender and age on statistics anxiety among students **[3.2]**. Most importantly, his findings highlight that the comparatively higher levels of anxiety among female students reported in most studies are actually driven by the low likelihood of reporting anxiety among *younger* men, rather then men in general. In fact, it is *older* men who are most likely to report experiencing statistics anxiety. On a general level, this finding suggests that possible 'complacency' is as important a factor to acknowledge and address by teaching professionals as 'anxiety' is. In practical terms, this means that a level of statistics anxiety is beneficial to learning if instructors can channel it to positive outcomes through employing

"sophisticated learning-teaching approaches" that "require the complex layering of a range of pedagogical strategies and tactics" **[3.2, page 9]**.

To tap into the pedagogical opportunities that emerge from these findings, Ralston has developed a 'Layered Pedagogical Model' as a coherent approach to implementing a range of methods that positively influence learning outcomes **[3.1; 3.2]**. The strength of the model is that it can be adapted to various contexts, study levels and curriculum contents. It only requires the flexible 'layering' of different strategies to (1) deliver the substantive statistical knowledge, (2) reduce 'epistemological anxiety' and (3) empower students to gain control over their 'statistics anxiety' through self-awareness.

The 'Layered Pedagogical Model' is the primary tool through which Ralston's research is achieving a positive impact on teaching practice and learning outcomes, particularly in the field of sociology, where the intersection between epistemological anxiety, statistics anxiety and complacency is acute. To achieve measurable and far-reaching impacts on students, teaching practices and the future statistical skills base of UK sociology graduates, the research has identified specific barriers to improved statistics learning, and it used these insights to create pathways to impact through a three-step research-to-impact strategy.

First, the research has identified that the very question of what hinders sociology students' positive learning experience of quantitative methods is not even posed in the main disciplinary and methodological journals read by academic sociology professionals in the UK. The first step towards making a positive impact on methodological teaching practices is therefore to raise awareness of the problem and the proposed solution (the 'Layered Pedagogical Model') in the outlets with which sociology lecturers engage most, such as the flagship journals of the British Sociological Association.

Second the research has made clear that epistemological and statistical anxiety becomes enshrined in the self-perception of students during their pre-university studies **[3.1; 3.2]**. It is therefore a structural feature of the educational system and as such, needs to be already tackled during the pre-university years. Consequently, training sessions should be targeted at secondary school pupils and teachers as much as at higher education students and instructors.

Third, and most importantly, the pedagogical principles underpinning the 'Layered Pedagogical Model' should be implemented not only in conventional teaching contexts (such as classroom teaching), but also through new modes of technology-assisted dissemination such as gamified teaching and learning platforms.

3. References to the research (indicative maximum of six references)

[3.1] Ralston, K. (2019) ''Sociologists Shouldn't Have to Study Statistics': Epistemology and Anxiety of Statistics in Sociology Students', *Sociological Research Online*. Vol. 25(2) 219–235, https://doi.org/10.1177/1360780419888927.

[3.2] Ralston, K., V. Gorton, J. MacInnes, V. Gayle and G. Crow (2020) "Anxious women or complacent men? Anxiety of statistics in a sample of UK sociology undergraduates", *International Journal of Social Research Methodology*, https://doi.org/10.1080/13645579.2020.1761186.

4. Details of the impact (indicative maximum 750 words)

The three-step pathway to impact strategy mentioned in Section 2 has involved the active dissemination of the designed 'Layered Pedagogical Model' to relevant industry decision makers and teaching professionals, as well as its practical application in teaching in various contexts. These activities have changed teaching practices among educational professionals and improving learning outcomes for students both in the UK and internationally. We detail these impacts by working backwards through the three steps of the pathway strategy.

1. Impact through Educational Technology Product Development

The 'Layered Pedagogical Model' designed by Ralston is a pedagogical tool that can be applied in both conventional teaching settings and through various new technology-assisted platforms. The latter allow for a much wider reach and can also complement classroom teaching. This has been recognised by Educational Technology (EdTech) entrepreneurs, who are using Ralston's research to develop new software for teaching statistics in ways that acknowledge and reduce statistics anxiety. A prominent example is 'Sunny Numbers', an Ireland-based EdTech start-up specialising in gamified statistics. The company develops mobile games "to help higher education students to learn statistics in a convenient, playful and engaging way". It is their "mission to create digital solutions that minimise statistics anxiety" **[5.1]**.

In her letter of testimony, the founder of Sunny Numbers describes the ways in which Ralston's research **[3.1; 3.2]** has impacted upon all aspects of their work, from initial concept design to the final product: "Dr Ralston's work has inspired us to create a novel pedagogical tool using gamification to teach quantitative research methods. His research emphasises the need of designing practical interventions to enhance statistics learning", while "most of the research available on statistics anxiety continue to focus on predictive factors, characteristics and implications". In addition, "Dr Ralston's research gave us a better understanding on the complex relationship between gender and statistics anxiety (…). His findings helped us to identify and target the right consumer market for our product", and "have been used to shape our product development to make sure we are using the right pedagogical approach" **[5.1]**. Through this direct impact on the development of an EdTech product, Ralston's 'Layered Pedagogical Model' has produced a tangible tool for improving quantitative methods teaching and learning outcomes at various study levels.

2. Impacting the teaching practices of higher education professionals

Ralston's 'Layered Pedagogical Model' has also impacted teaching practices in conventional educational settings. To test the effectiveness of the pedagogical approach, it was first implemented at York St John University by Ralston, where he assessed changes in student satisfaction with a 2nd-year introductory quantitative methods module over two years. With the course content, aims and assessment tasks remaining the same, average student satisfaction scores with the module increased from 2.45 to 4 (measured on a 1–5 Likert scale where 1 = very unsatisfied and 5 = very satisfied) after the Layered Pedagogical Model was introduced to acknowledge and manage statistics anxiety **[5.2]**. This difference clearly indicates greater comfort with the material.

The principles of the Layered Pedagogical Model were then also implemented by other colleagues teaching quantitative methods at York St John University. According to the testimonial of one colleague, "Ralston's findings have helped me re-evaluate my own teaching of quantitative methods. In the 2020/2021 academic year I started my course with a short questionnaire containing questions on statistics anxiety. This data was then used not only for practicing data entry into statistical software, but also for a discussion about how we can acknowledge and overcome our anxieties about 'numbers'. This exercise has proved extremely helpful, and students were much more open in the tutorials about their difficulties, which has helped to overcome them more easily" **[5.3]**.

Through demonstrating the 'Layered Pedagogical Model' at several workshops for quantitative methods teaching professionals, Ralston's research has impacted on higher-education teaching across the UK and internationally. For example, Ralston co-organised three sessions on "Meeting the Challenges of Teaching Quantitative Research Methods" at the European Survey Research Association (ESRA) Biennial Conference in Zagreb (Croatia) in July 2019. Of the 12 international participants with teaching responsibilities as part of their main job, 7 stated on the session feedback form that they "will incorporate something that I heard into my teaching practice" **[5.4]**. Another National Centre for Research Methods training session on 'Statistics Minus Anxiety' delivered at York St John University in December 2019 attracted academics involved in quantitative methods teaching from across the UK Higher Education landscape and beyond (e.g. University of Potsdam, Germany). Feedback from the participants has indicated that around half of the participants thought it "very likely" or "fairly likely" to "implement ideas related to the Layered Pedagogical Model" in their teaching **[5.4]**.

A senior lecturer in quantitative methods at Edinburgh University's Q-Step Centre who attended the NCRM training session in December 2019 explains in a letter of testimony how her teaching practice has benefited from Ralston's research. According to her, the "challenge of quantitative methods teaching within the UK social sciences cannot be underestimated. (…) A large part of the battle in teaching quantitative methods is convincing students of the value of this topic, and convincing more anxious students that they are capable of successfully mastering the material. (…) Attending the NCRM training event 'Statistics Minus Anxiety', held at York St John University, provided a valuable opportunity to share our experiences and to learn from the latest research (e.g. Ralston 2020 and Ralston et al. 2021). Dr Ralston's research has cemented my understanding of the importance of demonstrating the legitimacy of statistical approaches, which now forms a central element of my teaching strategy. This is used alongside strategies to acknowledge student anxiety. This layered pedagogic model of teaching has been beneficial, and I use it in my current quantitative methods teaching" **[5.5]**. The fact that Ralston's research has positively impacted methodological teaching practices at an established Q-Step institution **[5.10]** – which is "a major strategic programme designed to promote a step-change in quantitative social science education and training in the UK" (https://www.nuffieldfoundation.org/students-teachers/q-step) – evidences that the research has been accepted as an important approach that is leading to an improvement of the statistical skill base of UK sociology in the long-term.

3. Reducing epistemological and statistics anxiety among secondary-school age pupils

In order to achieve positive impact among pre-university age learners, Ralston delivered training courses on 'Getting Comfortable with statistics' to 6th-form pupils from John Leggott College and from North Yorkshire opportunity areas as part of Network Rail's Fast Trackers project. The courses directly followed principles from the Layered Pedagogical Model by overtly acknowledging the learners' epistemological and statistics anxiety through the exercises and open discussion and building on that acknowledgment to mitigate the hindrances posed to learning by these anxieties.

The effectiveness of the pedagogical model developed by Ralston has been acknowledged by the Project Director of the National Collaborative Outreach Programme (NCOP), who had approached Ralston for the delivery of training sessions to pre-university learner cohorts. In the words of the NCOP Project Director: "we were aware of [Dr Ralston's] pedagogical work around teaching those with maths/statistical anxiety and his expertise in applying and teaching statistical methods. The course provided by Dr Ralston was aimed to engage all students, but especially those who may not have felt especially confident in maths. The session helped them see how their maths learning can be applied to many different applications and careers. All the students were fully engaged in the session and clearly understood how they could apply this new learning to the regional engineering competition they were due to participate in. The students said that they felt more familiar with learning and teaching approaches at university thanks to the workshop. One young person commented, 'I like the way the speaker put across the information,' another found it 'very informative' and a third said that they liked 'how the information was presented as it was understandable.'" **[5.6]**.

The effects of the training on pupils were also assessed using before/after feedback questionnaires that measured pupils' initial attitudes and anxieties and their attitudes afterwards. Out of 18 pupils, 10 noted that "Today's workshop made me feel more confident about statistics" (responses of 4 and 5 on a 1 to 5 scale), and the number of pupils answering that "After I have finished in education, I would be comfortable in having a job that involves statistics" also increased by 2 (responses 4 and 5 on a 1 to 5 scale) **[5.7]**. The positive effect of a brief practical training offered to disadvantaged pupils distanced from higher education (the remit of the National Collaborative Outreach Programme) has also demonstrated the strengths of the teaching approach designed by Ralston when applied in pre-university training environments.

4. Raising awareness within professional sociology

An elementary barrier to improving quantitative methods teaching in sociology was that instructors were not even aware that factors extraneous to the course content and delivery style (such as epistemological or statistical anxiety) are crucial to the learning experience and outcomes. Sociologists teaching quantitative methods feel that "there is very little formal pedagogical research to inform the practice of quantitative methods teaching" **[5.5]**. The only practical solution they find available to address student dissatisfaction and poor performance is reducing the complexity of the material. This, however, fails to improve performance and satisfaction, leading only to a general reduction in the statistical skill base of UK sociology. Thus, it was important for the research to reach the relevant audience by being published in a generalist mainstream forum such as a flagship journal of the British Sociological Association (BSA) **[3.1]**. To reach the stakeholders who can implement the proposed pedagogical method, academic publication avenues were a main pathway.

Data from Altmetric evidences the success of this approach. Ralston's first (2019) article on epistemological anxiety **[3.1]** has achieved an Altmetric score of 14, which places it "In the top 25% of all research outputs scored by Altmetric" and counts as a "High Attention Score compared to outputs of the same age (86th percentile)" **[5.8]**. Ralston's ground-breaking article has influenced teaching practices not only in the UK, but internationally. For example, an academic from Alpen Adria University in Klagenfurt, Austria used it "in an interactive activity" in her own teaching **[5.9]**.

Ralston's second article challenging previous findings on the gender divide in statistics anxiety **[3.2]**, on the other hand, was featured in the Summer 2020 issue of the BSA's 'Network' magazine (https://britsoc.co.uk/media/25332/network_summer_2020.pdf). This wide readership and influence achieved in mainstream disciplinary forums is evidence that Ralston's research has succeeded in raising awareness among UK sociologists of the pedagogical methods available to reduce statistics anxiety among students and thus enhance the quality of learning, contributing in this way to the improvement of the future statistical skill base of UK sociology.

5. Sources to corroborate the impact (indicative maximum of 10 references)

[5.1] Testimonial: Founder, 'Sunny Numbers', Educational Technology Company

[5.2] Report: York St John University student module evaluations.

[5.3] Testimonial: Senior Lecturer, York St John University.

[5.4] Feedback forms from two workshops (ESRA, 16th July 2019, and NCRM, 16th December 2019).

[5.5] Testimonial: Senior Lecturer, University of Edinburgh.

[5.6] Testimonial: Project Director, National Collaborative Outreach Programme (NCOP).

[5.7] Survey Data: Pupil feedback forms from the 'Getting Comfortable with statistics' training course, Network Rail's Fast Trackers project John Leggott College, 20th March 2019.

[5.8] Report: Sage Article Metrics for "'Sociologists Shouldn't Have to Study Statistics': Epistemology and Anxiety of Statistics in Sociology Students" (https://sage.altmetric.com/details/74472578)

[5.9] Correspondence: Lecturer, Alpen Adria University Klagenfurt

[5.10] Testimonial: Director, School of Social and Political Science Research Training Centre, University of Edinburgh