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# Changing perceptions among adult learners (19+) in further education studying GCSE mathematics:

## Methodology and data analysis - the importance of the pilot

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*A Doctorate in Education in the UK generally involves four modules prior to the thesis phase. Two of the modules are focussed on the pilot study, the first on the methodological rationale, and the last on the analysis of the data collected. Although this process can be seen by post graduate researchers as a delay to the actual data collection, it can be highly informative and make a substantial contribution to the thesis. In this example, the efficacy of a questionnaire, developed from the Abbreviated Maths Anxiety Scale (AMAS) (Hopko, Mahadevan, Bare, & Hunt, 2019), was tested with adults studying GCSE mathematics, whilst developing an understanding of action research, insider research and thematic analysis.*

*Keywords: GCSE mathematics, further education, pilot study, perceptions, math anxiety.*

## Introduction

Adult learners studying GCSE mathematics in a Further Education (FE) college, whilst being highly motivated to re-engage with the classes, often due to extrinsic motivations such as career changes, can present with a degree of anxiety about either mathematics, or examinations, or both. It is unknown whether for these learners' mathematics and exam anxiety are linked, if the levels change during the courses, and if confidence, or lack of it, impacts on exam results.

The prevalence of mathematics and exam anxiety is becoming increasingly well documented. Recent research funded by the Nuffield Foundation (Nuffield Foundation, 2018) includes two studies, one on GCSE resits mathematics for 16- to 18-year-olds (Hough, Solomon, Dickinson, & Gough, 2018), and one on mathematics anxiety in pupils at Primary and Secondary schools (Szucs, McLellan, & Dowker, 2017). Research also exists which has analysed the experiences of traditional pathway students in Higher Education (Evans J., 2000). However, few studies exist which consider the effects of previous experiences in mathematics classrooms on non-traditional adult learners returning to education after a break or map the attitudes of those adults towards mathematics or examinations.

The pilot study mapped confidence levels for both mathematics and examinations against exam results for a small group of adults (n=18), to evaluate for a correlation between confidence and success. It might seem that it is likely that more anxious learners are less likely to succeed, but not all research supports this view (Mandler & Sarason, 1952; Tavani & Losh, 2019). There also seems to be a lack of clarification around whether mathematics or exam confidence, or both, are linked to exam success.

The research design for the pilot study was a mix of quantitative and qualitative methods, to gain a broad understanding of the experiences of adult learners (Clough & Nutbrown, 2007). A modified 'Abbreviated Mathematics Anxiety Survey' (AMAS) (Hopko, Mahadevan, Bare, & Hunt, 2019), a

tried and tested survey in the public domain, was revised to change the labelling of the scale to include confidence, rather than just anxiety, and to gather comments from learners. It was re-named it MECS (Mathematics and Examinations Confidence Scale) to differentiate it from the original. Learners were surveyed in April, after curriculum input and as learners move into the revision phase, using the questionnaire.

Questionnaire responses were matched to examination results, to evaluate for a correlation between confidence levels of both mathematics and examinations against outcomes. This analysis is presented on scatter graphs, and expanded into gender, nationality, and age comparisons.

The doctoral thesis of which this pilot study forms a part aspires to make an original contribution to the understanding of factors in mathematics delivery for adults in the UK, which may differ from their experience in previous educational settings.

## Summary of research questions

The main research questions are:

- Do courses in FE colleges change adult learners' perceptions of GCSE mathematics and/or examinations and, if so, how, and why?
- Is a relatively high confidence level necessary for exam success?
- Are more anxious students less likely to pass?
- The research questions for the pilot study are:
- Does the MECS questionnaire give sufficient information to formulate answers to these questions?
- Did participants find it easy to understand and use?
- Is an analysis by themes helpful for understanding the data collected?

## Methodology and methods of the pilot study

### Action Research

Action research is the phrase used to describe research, which is conducted by practitioners in the field, linking research to practice (Burgess, Sieminski, & Arthur, 2006; Munn-Giddings, 2017). It can often be linked to an intervention, which is designed to improve practice for teachers, or outcomes for students, or both (Wilson, 2017; Munn-Giddings, 2017; McNiff, 2016). The project aspires to both describe the experiences of adults returning to mathematics classes, and work towards interventions that could improve outcomes for learners, either at a micro or macro level, i.e., either for a learner, a particular classroom, adult learners in FE colleges, or even to the wider mathematics educators' community (Creswell, 2012).

In addition to describing this pilot study as action research, it can also be described as participatory action research, as participants are involved in the research process. This is because, in addition to collecting data, some participants have been asked to evaluate the questionnaire (Munn-Giddings, 2017, p. 72; Cohen, Manion, & Morrison, 2018).

**Mixed Methods**

A mixed method approach was chosen to allow for some 'triangulation' of data, as it can be cross referenced to show reliability of the findings (Maguire, 2019; Cohen, Manion, & Morrison, 2000). Cross referencing refers to using more than one method to collect data (Mason, 2018; McNiff, 2016), or by using more than one set of people (McNiff, 2016). In the pilot study both quantitative and qualitative data have been collected in the questionnaire.

There is an issue with a mixed method study, that it may be seen as pseudo-scientific, blurring the demarcation line between positivist and interpretivist approaches, and making the research sound more scientific than may be justified (Cohen, Manion, & Morrison, 2018; Mason, 2018).

## The Survey Method: A questionnaire

The method for data collection tested in the pilot was a questionnaire, because in the mathematics education field the Abbreviated Mathematics Anxiety Scale is often mentioned in research, and has been adapted in many ways, including for use with younger children (Hopko, Mahadevan, Bare, & Hunt, 2019; Psychological Toolkit, 2018). Adapting an existing survey both adds academic weight to the main study, as it is tried and tested by other researchers, and avoids the major challenge of constructing and testing a survey from scratch (Wilson, 2017; McNiff, 2016).

Questionnaires can generate a lot of data quickly, as they are generally easy to complete, can include both quantitative and qualitative questions, and responses can be easily anonymised (Clough & Nutbrown, 2007; Cohen, Manion, & Morrison, 2018). The pilot study evaluated the questionnaire to see whether the participants could respond positively, neutrally, or negatively to the questions posed, and whether patterns emerged, even though there was a small sample size (Taber, 2017; Cohen, Manion, & Morrison, 2018).

The disadvantages of a questionnaire include that the information they generate might be quite superficial, as respondents will not necessarily answer thoughtfully and accurately, and that there is little or no opportunity for the researcher to follow up on comments, unless permission for contact has been included in the questionnaire (Cohen, Manion, & Morrison, 2000; Clough & Nutbrown, 2007)

One of the significant changes made to the AMAS questionnaire was to alter the Likert Scale (Hopko, Mahadevan, Bare, & Hunt, 2019). The original uses the word 'anxiety' throughout, as students are asked to grade themselves in the following way:

1 Low anxiety, 2 Some anxiety, 3 Moderate anxiety, 4 Quite a bit of anxiety, and 5 High anxiety.

This was altered to:

1 Very confident, 2 Confident, 3 Neutral- neither confident nor anxious, 4 Anxious, and 5 Very anxious

This was altered to moderate the potential for a presumption for anxiety. The original survey could be interpreted as leading the students to an expectation of an answer, an outcome that should be avoided, as it can lack objectivity (Burgess, Sieminski, & Arthur, 2006; Sfard, 2013; Wilson, 2017).

In extreme examples the questions "can influence respondents and alert them to ideas they had not thought about before" (McNiff, 2016, p. 184).

The second change was to include comment lines, to allow learners to add to their numerical response, which changed the questionnaire into a mix of quantitative and qualitative data and canvassed opinions on the statements. An 'any other comments' section at the end of the questionnaire was also included, to enable participants to share other issues or thoughts.

Other minor adaptations introduced were to change the American language to a more UK version of English, and to add one additional question, to ask how confident learners would feel taking any other, non-mathematics exam. This was to try to evaluate whether it is all examinations that students feel anxious about, or specifically exams in mathematics.

### Sampling

Opinions on sample sizes for pilot studies can be very divided, with some sources saying that a few respondents would be enough (Burgess, Sieminski, & Arthur, 2006), but other sources specifying a minimum of 30 (Cohen, Manion, & Morrison, 2000). In this pilot study the number of participants was eighteen (n=18).

The sample for the pilot study was drawn from one FE college, so may be unrepresentative of the total population of adults studying in colleges and could also be seen to be biased (Burgess, Sieminski, & Arthur, 2006; Oates, 2006), as the learners may have modified their answers knowing that their 'teacher as researcher' was going to see them. This is described as the halo effect in Cohen et al (2018), but as the pilot study tested the format of the questionnaire, rather than used the data, it has still given a useful insight on whether the questionnaire is acceptable to participants.

There was also no attempt to gain a representative sample from the classes, such as a mix of those who might be confident or anxious, or a mix of gender, ages, or nationalities (Oates, 2006). Participation by learners was voluntary and on an opt in basis.

## Data Analysis: chosen method and analysis

### Thematic Analysis

In this pilot study a mix of quantitative and qualitative data has been collected in a mixed method study. Thematic analysis seems to be a suitable theoretical framework for data analysis and interpretation, as it is a flexible approach which can encompass both types of data (Nowell, Norris, White, & Moules, 2017; Braun & Clarke, 2013). It can also reflect the complexity of the data, as use of several different perspectives or data sources can be shown in the codes, and these can be used to support and illustrate the themes, and to triangulate the data (Creswell, 2012; Cohen, Manion, & Morrison, 2018).

The pilot study data analysis looked for patterns in the data around themes, such as course content and examinations, and learner characteristics such as age, gender, and nationality, to see if this way of analysing yielded useful insights and added to understanding, if only to the complexity of educational research.

## Research Findings

The total score for each participant from the questionnaire was used in a number of scatter graphs to compare confidence levels with exam results; the decision to use these in the analysis was based on the need to test whether they would be a useful way to display the two forms of primary data in a single format (Burgess, Sieminski, & Arthur, 2006; Spiegelhalter, 2019). Scatter graphs are a statistical representation designed to show comparisons between two variables, which could have an appeal to wider audiences (Creswell, 2012; Thomas, 2013). In scatter graphs it is possible to see if patterns emerge, and if correlations exist between data sets (Braun & Clarke, 2013; Evans M., 2017). The numbers involved in the pilot study means that it was a small data set, and no conclusions can be drawn on the content, but the use of scatter graphs has been explored in this pilot study.

Four scatter graphs were constructed. The first two illustrated the very broad themes of confidence and anxiety compared to exam performance but contrasted the use of grades and scores. In these two graphs the slope of the trend line was virtually identical, which relieves a practical challenge for the research, as scores will be more difficult to capture than grades, as learners only receive grades. There is a further benefit as colleges that agree to participate in the main study are likely to use different exam boards with unique marking structures for grades, so scores would not be a viable method of comparison.

There was a slight correlation between the level of confidence and the outcome of the exams. This could indicate that there was a causal relationship between anxiety and success, and more anxious learners were less likely to pass (Spiegelhalter, 2019; Creswell, 2012). However, the slope of the trend line, (also known as a line of best fit, or regression line), and even its aspect, varied depending on which part of the group is investigated, which illustrates the importance of examining data by different themes, to enhance its validity (Cohen, Manion, & Morrison, 2018; Creswell, 2012).

Further scatter graphs illustrated analytical differences in gender and age, two themes identified as present in existing literature on the subject. When males are selected from the participants, there is a stronger relationship between levels of confidence and success in the exam, which means for females the correlation is weaker. However, if females are examined as a group, there are some clear examples of participants who are very anxious and high achievers, who could be seen as outliers. In this small sample size, it is not possible to draw any conclusions from this, but it does confirm the important of collecting the gender of participants for investigation and confirms the use of gender as a theme.

When participants under the average age were selected, the aspect of the trend line changed so that now more anxious students were more likely to pass; this could reflect the need for a certain amount of anxiety to maximise performance (Yerkes & Dodson, 1908), but it was unexpected, and shows the advantage interrogating data thoroughly using thematic analysis to ensure its validity (Nowell, Norris, White, & Moules, 2017). It also probably shows the danger of drawing inferences from small samples (Cohen, Manion, & Morrison, 2018; Creswell, 2012).

In addition to organising this data into themes, other calculations have taken place, such as enumeration of the range used on the Likert scale. One concern was that participants might be unlikely to use the full range of a Likert scale, as most would use 2, 3 or 4, if the scale is 1 to 5, and avoid the extremities (Cohen, Manion, & Morrison, 2018). This was tested in the pilot study and participants

had no problem with using the full range of the scale, indicating that they had no problem with deciding how strongly or otherwise they felt about the content. This may reflect the strength of feeling there is about mathematics generally, either positively or negatively. The use of a Likert scale allowed for the data to be analysed in several different ways, such as by ranking the questions from most confident to most anxious, which could yield different insights and understanding.

Over half of the twenty respondents used the comments sections, and on average each person commented on approximately half of the questions.

Learners involved in the review confirmed that they felt the AMAS document was leading, in terms of anxiety, and that they preferred the MECS questionnaire. When asked about the use of questionnaires in general, they felt that the intervention had been beneficial, as it implied that it was 'okay to be anxious', that it was normal for the whole class and thus acceptable. The survey took around 5 to 10 minutes to complete, which was not too demanding on peoples' time and energy. The small group review of the AMAS vs MECS questionnaires took approximately 20 minutes.

## Conclusions

To repeat, the research questions for the pilot study are: Does the MECS questionnaire give sufficient information to formulate answers to these questions? Did the learners find it easy to understand and use? Is thematic analysis a useful approach for data analysis?

The current MECS questionnaire seems to have worked well, as it covered assessment in various forms, classroom dynamics, and course content such as number work and algebra, and the language used in it seems to have been understood by the participants.

There were no negative comments from learners about the language used, or the time taken. The participants completed the questionnaire in different ways, some using the numbered scale, and some the words attached to the numbers, which demonstrated a useful flexibility.

Thematic analysis as a framework to organise, interrogate and interpret the information seems to be a useful method, both for the insights it could yield, and for the accessibility of the data in subsequent presentations.

The contribution of the pilot study to the final project and subsequent thesis is clearly substantial. The interrogation of the content and process of implementation of the questionnaire used in the pilot study, and the development of themes and codes, have all made significant contributions towards an understanding of the research issues, which will be highly beneficial for the main study. It could also lead to an expansion of the data, "to formulate new questions and levels of interpretation" (Coffey & Atkinson, 1996, p. 30; Gibbs, 2017), leading to the generation of new theories to explain phenomena in mathematics education for adults.

## References

Braun, V., & Clarke, V. (2013). *Successful Qualitative Research*. Sage Publications.

Burgess, H., Sieminski, S., & Arthur, L. (2006). *Achieving Your Doctorate in Education*. Open University/Sage Publications.

Clough, P., & Nutbrown, C. (2007). *A Student's Guide to Methodology (2nd Edition).* Sage Publications.

Coffey, A., & Atkinson, P. (1996). *Making Sense of Qualitative Data*. Sage.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research Methods in Education (5th Edition).* Routledge Falmer.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education (8th Edition).* Routledge.

Creswell, J. (2012). *Educational Research (4th Edition)*. Pearson.

Evans, J. (2000). *Adults' Mathematical Thinking and Emotions.* Routledge Falmer.

Evans, M. (2017). *Analysing Qualitative Data. In E. Wilson, School-based Research: a guide for education students (3rd Edition)* (pp. 260-273). Sage Publications Ltd.

Gibbs, G. R. (2017). Using software in qualitative data analysis. In R. Coe, M. Waring, L. V. Hedges, & J. Arthur (Eds.), R*esearch Methods and Methodologies in Education (2nd Edition)* (pp. 243-251). Sage Publications Ltd.

Hopko, D., Mahadevan, R., Bare, R., & Hunt, M. K. (2019, March 14). *The Abbreviated Math Anxiety Scale.* https://www.psytoolkit.org?survey-library/math-anxiety-amas.html

Hough, S., Solomon, Y., Dickinson, P., & Gough, S. (2018, June 16). *Achievements and attitudes in GCSE mathematics resit classes.* http://www.nuffieldfoundation.org/achievement-and-attitudes-gcse-mathematics-resit-classes

Maguire, K. (2019). Methodology as personal and professional integrity. In C. Costley, & J. Fulton (Eds.), *Methodologies for Practice Research: approaches for professional doctorates* (pp. 95-115). Sage.

Mandler, G., & Sarason, S. B. (1952). A study of anxiety and learning. *The Journal of Abnormal and Social Psychology, 47*(2), 166-173. https://doi.org/10.1037/h0062855

Mason, J. (2018). *Qualitative Researching (3rd edition)*. Sage.

McNiff, J. (2016). *You and Your Action Research Project (4th edition).* Routledge.

Munn-Giddings, C. (2017). Action Research. In R. Coe, M. Waring, L. V. Hedges, & J. Arthur (Eds.), *Research Methods and Methodologies in Education* (pp. 71-77). Sage.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods, 16,* 1-13. https://doi.org/10.1177/1609406917733847

Nuffield Foundation. (2018, June 9). http://www.nuffieldfoundation.org/mathematics-education-0

Oates, J. (2006). Ethical Framework for Research with Human Participants. In S. Potter (Ed.), *Doing Postgraduate Research (2nd edition)* (pp. 200-227). Open University/ Sage Publications.

Psychological Toolkit. (2018, June 16). *Abbrieviated Math Anxiety Scale*. https://www.psytoolkit.org/survey-library/math-anxiety-amas.html

Sfard, A. (2013). Not just so stories: practising discursive research for the benefit of educational practice. In V. Farnsworth, & Y. Solomon (Eds.), *Reframing Education Research* (pp. 139-150). Routledge.

Spiegelhalter, D. J. (2019). *The Art of Statistics- Learning from Data*. Pelican Books.

Szucs, D., McLellan, R., & Dowker, A. (2017, September 18). *Understanding Mathematics Anxiety*. http://www.nuffieldfoundation.org/understanding-mathematics-anxiety

Taber, K. (2017). Building theory from data: grounded theory. In R. Coe, M. Waring, L. V. Hedges, & J. Arthur (Eds.), *Research Methods and Methodologies in Education* (pp. 139-153). Sage.

Tavani, C. M., & Losh, S. C. (2019, April 4). *Motivation, self-confidence and expectations as predictors of the academic performances among our high school students*. https://www.questia.com/library/journal/1G1-116924600/motivation-self-confidence-and-expectations-as-predictors

Thomas, G. (2013). *How to do your research project: A guide for students in education and applied social sciences (2nd edition)*. Sage.

Wilson, E. (2017). *School-based Research: A guide for education students (3rd Edition).* Sage.

Yerkes, R., & Dodson, J. D. (1908). The Relationship of Strength of Stimulus to Rapidity of Habit-Dormation. *Journal of Comparative Neurology and Psychology,18*, 459-482.