Challenging stereotypes of adult learners in mathematics

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Published version

STACEY, Jennifer (2024). Challenging stereotypes of adult learners in mathematics. Language Issues, 34 (2), 41-51.

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Abstract

Mathematics courses up to Level 2 (GCSE) are free of charge in the UK, and offered by many providers, including FE colleges. Classes for adults (19+) can include a diverse range of learners in terms of their ages, gender and whether their first language is English or not. In this qualitative, mixed method research a number of participants completed a questionnaire, which included attitude scales for self-efficacy and anxiety, and opportunities for comments (n=21). The questionnaire gathered information about participants' perceptions of course content, classroom dynamics and assessment. When the data was analysed by participants' characteristics, it revealed that younger participants were more anxious and less likely to pass, that males were just as anxious as females, and that those whose first language was not English were more likely to pass, had higher self-efficacy and lower anxiety than first language English speakers. These findings challenge the findings of other research, and thus stereotypical assumptions of learners, which indicates a need for further study of this under-researched group.

Recommendations include surveying learners, using 'spiky profiles' to build confidence, encouraging learners to construct word problems, so that they can better engage with de-construction, and finally including techniques to manage examination anxiety.

Introduction

The purpose of this mixed method research was to increase our understanding of the diversity of adults (19+) who engage with GCSE mathematics in FE colleges, in terms of their self-efficacy and anxiety levels about mathematics. Self-efficacy is defined by Bandura in his 1997 work as a belief in or personal judgement on one's ability, as quoted in Holloway (2013).

The research compared the responses of participants to their examination grades, to address the question 'Does it matter?' For instance, a learner may be very anxious about an examination, or have doubts about their ability in the subject area, but still pass.

This paper describes one strand of the findings from data collected for a doctoral thesis, which I am completing on a part time basis at Sheffield Hallam University.

Context

The number of adults who were signed up for GCSE mathematics in 2020 was 30,650 in England alone (Gov.UK (1), 2020). The majority of these are likely to have received Teacher Assessed Grades (TAGS) due to the Covid 19 global pandemic. which caused the cancellation of public examinations.

GCSE mathematics, a level 2, fully funded qualification, is taken primarily by 16-year-olds in schools, and approximately 60% of students will pass at that stage. This

examination is a marker qualification for most entrances into university courses, in conjunction with Level 3 qualifications such as A levels or successful completion of Access to HE programmes.

The approximately 40% who do not pass at 16 will have to re-sit the examination until they leave education at 18 years old, or until they pass. Older (19+) learners who have not yet passed, adults who have migrated into the UK with or without mathematics qualifications from their country of origin, and UK residents with a first language other than English may have to re-engage with these courses to make progress in careers in England.

The label ‘L1’ is used in this paper to refer to those whose first language is English; ‘LX’ (Dewaele, 2018), will be used to indicate those who have another first language regardless of what this might be, e.g., for ESOL, EAL or ELL students. The term ‘LX’ was first suggested by Dewaele as a more inclusive phrase than other ways of referring to participants, such as native and non-native speakers. For the purpose of this research, the LX term protects the identity of participants, as it encompasses all of those participants whose first language was not English.

‘Spiky profiles’ is a term used to describe variations in ESOL learners’ abilities in English to speak, read and write the language, which may also be present in their first languages (Colquhoun & Delaney, 2009). The term has been used in mathematics to describe variations in adult learners’ abilities in different topic areas, such as number work compared to, say, algebra (Coben, 2003).

Literature review

Existing research shows a correlation between mathematics anxiety and performance for many age groups (Ashcraft & Moore, 2009), but adult learners, often on non-traditional pathways into Higher Education (HE) or engaging with career changes, may have different motivations to learners on traditional pathways (Bélanger, 2015; Tennant, 2006), which may alter or exacerbate that relationship. Consequently, adults may differ in their perceptions and performances from students on traditional pathways, as shown by existing research from the USA (Jameson & Fusco, 2014; Watts, 2011).

Research on mathematics anxiety in adults has been in the public domain for many years (Betz, 1978; Skemp, 1987). Analysis of adult learners’ characteristics in research have revealed that as learners get older, they generally become more anxious (Jameson & Fusco, 2014; Betz, 1978). Other research on students in school settings has shown that females are often more anxious than males (Hunt, Clark-Carter, & Sheffield, 2011; Szucs, McLellan, & Dowker, 2017). Research on school aged and adult students has shown that L1 English speakers will perform better than LX learners, perceived to be due to the language demands of the courses and examination papers (Kersaint, Thompson, & Petkova, 2013; Woolley, 2013).

This strand of my research explores whether these earlier findings, which may lead to the establishment of stereotypical assumptions about learners, applied to a small group of adult participants (n=21) on GCSE mathematics courses in FE in England.

As humans with survival mechanisms in place, we are naturally inclined to form assumptions about our relationships with others based on our previous experience, whether this is a result of what we have read, heard, or seen. However, stereotypical assumptions can be damaging for learners if teachers knowingly or unknowingly hold or believe in them, or if learners adopt or internalise them. Both of these can potentially encourage conformity to the stereotype in the mathematics classroom, with a subsequent reduction in ability for the affected group (Holloway, 2013).

In addition to investigating potential stereotypical assumptions, this research included an investigation into word problems. Changes in the GCSE mathematics curriculum over previous decades have involved a move away from more traditional algebraic and geometric content to mathematics which involves the interpretation of 'real life' problems, resulting in an increase in the language content of examination papers (Brown, 2001). This challenge has been explored by other researchers such as Evans (2000), who highlighted the challenges that adult learners might face with these questions. For instance, in one example learners are asked which box of cereals they would purchase, a smaller or larger size, based on the price of each. However, in real life learners might not be able to either afford or store a larger size, so the decision is not simply based on price (Evans, 2000).

Word based problems which require interpretation could be a challenge for both L1 and LX learners (Dewaele, 2018). This challenge, with ideas for solutions such as learners constructing their own word problems, has been identified in the field of mathematics by those concerned with both LX and L1 mathematics learners (Barwell, 2009; Swan, 2006).

Sample

A number of colleges and college groups were contacted in the East Midlands and South Yorkshire areas with a view to inclusion of their adult learners in this research.

College managers were contacted via an e mail which contained copies of the information letter, consent form and paper-based questionnaire, and a link to the online versions on a website approved by the university (Qualtrics, 2024). Due to the Covid 19 pandemic I was unable to visit classrooms to recruit participants, so a PowerPoint presentation with a voice over by myself, explaining the content and purpose of the research, was also included. Once consent for the research to proceed within individual colleges had been given, the email was circulated by managers to teachers, and subsequently to students.

Data was collected from more than one college, from several classes with different teachers, and in two academic years, namely 2020/21, and 2021/22. The extension of the data collection over two years was due to insufficient numbers engaging with the questionnaire in the first year, which was believed to be a result of a lack of face-to-face contact with potential participants, due to the restrictions imposed by the pandemic. The first group were subject to CAGS (College Assessed Grades), as public examinations were cancelled for the second year in a row. Public examinations were re-established for the 2021/22 group.

Methodology and methods

This research is based on a critical realist ontological perspective (Bhaskar, 2020), with its underpinning beliefs in the possibility of change, and the value of research as a catalyst for improvement. This research is underpinned by pragmatism; whilst the small numbers of participants in qualitative research cannot be generalised to larger populations, the research can be used to describe perceptions which are present within the population, which may lead to further investigations and research, and be used to inform teaching and learning.

A mixed method approach has been taken to the data collection (Cresswell, 2014), as a questionnaire has been the main source of data. The mixed method approach of using a questionnaire, which incorporated a combination of attitude scales and opportunities for comments, was chosen because it was found to be an effective method to gather the required data: the pilot study demonstrated that participants found it easy to understand and use. In addition, all participants were offered the opportunity for a semi-structured interview to correct or elaborate on the perceptions and insights gained from the questionnaire.

The questionnaire consisted of 15 statements, nine of which were based on the Abbreviated Math Anxiety Scale (AMAS) (Hopko, Mahadevan, Bare, & Hunt, 2003), which has been validated by extensive testing and confirmed as just as effective as much larger surveys (Hopko, 2003). The six additional statements were based on the findings from other research, including that of Evans (2000), the pilot study, and the personal knowledge gained from almost 20 years of teaching mathematics to L1 and LX adults.

The AMAS questionnaire's nine statements include using the tables at the back of a maths book, thinking about an upcoming test one day before, watching a teacher work an algebraic equation on the board, taking a mathematics examination, being given a homework of many difficult problems which is due in the next class, listening to a lecture in a mathematics class, being given a 'pop' quiz, and starting a new chapter in a mathematics book. These were amended to improve their relevance and suitability, e.g., 'using the tables' was amended to using a times table grid, the word 'pop' was dropped from the quiz statement, and 'starting a new chapter' was altered to 'starting a new topic'.

The additional statements which were unique to this research included one on word problems, another on drawing charts and graphs, rather than interpreting them, and a statement on non-mathematics examinations, to allow for a comparison between participants' views of mathematics and other examinations. The word problem given to participants was 'Working on word problems, such as if it takes 3 people 5 days to fit a kitchen, how long would it take 2 people?'

The three additional statements drawn from other sources, included one on percentages, one on fractions and another on asking a question in class (Evans, 2000).

Each statement was accompanied by two scales, one for self-efficacy, and one for anxiety. The choices on the self-efficacy scale ranged from 'very confident' to 'I

definitely can't do this'. The choices on the anxiety scale went from 'no anxiety' to 'high anxiety'. The scales are shown in Table 1.

Self-efficacy scale	Very confident	Quite confident	Don't know	I don't think I can do this	I definitely can't do this
Anxiety scale	No anxiety	Some anxiety	Moderate anxiety	Quite a bit of anxiety	High anxiety

Table 1: Attitude scales included in the questionnaire.

The use of two scales was justified by the understanding that self-efficacy and anxiety are two very different emotional states, which can evoke very different responses to stimuli. For instance, a learner might be quite confident when they go in for a public examination, but still very anxious about it. Equally one might say 'I don't think that I can do this' when faced with the tasks of drawing a chart or graph but have no anxiety about the prospect of doing so.

Participants were given the opportunity to make comments after each choice and at the end of the questionnaire.

The data analysis was thematic (Braun & Clarke, 2013), based on both the themes identified in the questionnaire content, and additional themes that emerged from the analysis.

Analysis

The number of participants who responded to the questionnaire was 21 in total, which yielded 630 ranked responses to the 15 statements, 315 for self-efficacy and 315 for anxiety. Approximately 100 comments were collected.

The participants characteristics in terms of age, gender and first language were:

Age: Four participants were 19 to 24 years, 17 were 25 or more.

Gender: Three participants were male, 18 were female

First language: Four were LX users, 17 were L1 English users.

Overall, 13 out of the 21 participants passed at their first attempt on the GCSE mathematics examinations, although a number passed on their second attempt, showing the value of persistence in mathematics.

The choices on the self-efficacy scale, which ranged from 'very confident' to 'I definitely can't do this', were ranked from one to five, and the anxiety scale choices, which went from 'no anxiety' to 'high anxiety', were also ranked from one to five. When the scores for individuals were added together it gave totals for self-efficacy and anxiety for each participant, which allowed for a median (middle) value to be established. The data for individuals was then categorised as either high or low self-efficacy and anxiety, compared to whether they were above or below the median value.

Based on this analysis, the findings are that those with high self-efficacy and low anxiety tended to pass the examination (n=7), and that those with low self-efficacy

and high anxiety tended to fail (n=4), but there were exceptions to both of these statements, as two of those with high self-efficacy and low anxiety failed, and three with low self-efficacy and high anxiety passed.

When the data is interrogated by age, only one of the four 19–24-year-olds passed, thus a low pass rate, and although they displayed similar self-efficacy levels to the 25+ participants, they showed higher anxiety levels. None of the younger participants provided additional comments.

Males in this research (n=3), one of whom was an LX participant, showed lower self-efficacy and higher anxiety than some females and had a similar pass rate. All of the males made comments on their questionnaires, which expressed a number of issues including concern about word problems, algebra, testing generally, and worries about the opinions of their peers. These comments were very similar to those made by the females (n=6). However, the two withdrawals and the three participants who could not ask a question in class were all female.

The four LX participants (three females and one male) in this research had generally higher self-efficacy, lower anxiety, and a higher pass rate than their L1 peers. In fact, three of the four passed, and the fourth LX participant (a female), withdrew from the course prior to the examinations. Three out of the four LX users made comments, which included the most positive comment made by any participant, which was “I am comfortable with math”.

Other LX participants expressed concern about word problems, and timed testing in all its forms, as did many of the L1 participants, as shown in Table 2.

Statement	Comments from LX participants	Comments from L1 participants
Word problems	‘I don’t know how to work it out’. ‘7.5 days?’	‘I read too much into it and panic…’ ‘I always struggle with wordy questions’
Doing a quiz in a maths class	‘It always brings anxiety’	‘The worry of a time constraint makes my mind numb’
Thinking about an upcoming maths test one day before	‘I’d try to keep myself calm and I’d encourage myself that I’d do fine’	‘The anxiousness would put my mind in a spin’
Starting a new topic in a maths class	‘There’s always some anxiety with new topics’	‘It depends on the topic, I think. Algebra is worrying me.

Table 2: Similarities of comments from LX and L1 participants

The comments made by participants and shown in Table 2 demonstrate the similarity of feelings and perceptions experienced. One slight difference between the L1 and LX users was that none of the LX users made any comments about the algebraic statements, in spite of a range of similar responses on the self-efficacy and anxiety scales, whereas many of the English speakers expressed concerns about this topic area even in statements that did not include algebra but mentioned ‘a new topic’.

However, there was also evidence of contrasts in some of the responses to the statements, such as the statement on percentages which showed that whilst some participants were competent in this area, others were not. For instance, the LX participant who used the questionnaire as an opportunity to answer the questions, correctly identified both a method and the correct answer, which demonstrated that percentage calculations are a strong topic for this participant. However, the two L1 participants who made comments both identified percentage calculations without a calculator as a challenge, with comments such as “I panic when I see the % sign” and “(the method) is not something that stays in my head”.

Conclusions

It is clear from the findings that for these participants, whilst high levels of self-efficacy and low levels of anxiety were desirable, they were by no means essential. This may be very re-assuring to adult learners studying mathematics, especially those whose onward journeys into HE could be affected by the results.

The findings from this qualitative research shows some contrasts with the generalisations made by other, larger scale research studies, and challenges stereotypical assumptions which might be present in mathematics classes around age, gender, and language issues. If present, these may be unhelpful for both teachers and learners (Holloway, 2013).

For instance, the younger participants in this study displayed higher levels of anxiety than the older ones and were less likely to pass, which indicates support for research which showed a correlation between anxiety and success (Ashcraft & Moore, 2009), but a challenge to research on age differences conducted with adults in the USA (Betz, 1978; Jameson & Fusco, 2014). If these findings on age are substantiated by a larger study, it could indicate a difference between the two countries, or a change over time in the UK, possibly as a results of curriculum changes (Brown, 2001).

The findings of this research contrast with larger, school-based studies completed in England, which found that males were generally less anxious than females (Szucs, McLellan, & Dowker, 2017; Hunt, Clark-Carter, & Sheffield, 2011). In this study males were just as much and sometimes more anxious than their female peers, which may reflect the fact that the perceptions of these males had been influenced by their prior experiences of ‘failing’ in mathematics, as none of them so far have passed the examination.

The deficit view of LX learners (Woolley, 2013; Kersaint, Thompson, & Petkova, 2013) has also been challenged by this research, as these participants were more likely to pass than their L1 peers, were less anxious, and expressed higher self-efficacy. In addition, the comments and ranked scores on the questionnaires of the LX participants indicated just as much, but not more, concern about word problems and timed testing as the L1 participants, and the comments made are strikingly similar. These findings indicate the importance of word problems for learners generally, which has implications for teaching, and shows the need to help learners with examination techniques, such as controlling breathing to reduce adrenalin levels.

Finally, there was evidence of spiky profiles in certain topic areas, such as percentages, which varied between learners.

Recommendations

My first recommendation is that practitioners conduct a short survey of their learners, probably not in the first week or two, when their responses might be more affected by the newness of the classroom, teacher, and peers, but certainly soon after that. I learned so much about these participants from their responses which would have informed both my teaching, and classroom management, especially in terms of word problems, and how I checked on the understanding of those who would not ask a question in class. This sort of information is not included in initial and diagnostic assessments.

I have developed a revised survey form which could be used for this, included here in Appendix 1. It fits on an A4 sheet with a text size of 11 and allows learners to add up their own scores. The key statements that came out of this research are included, and please note that some statements ask for self-efficacy, while those on timed testing ask for anxiety. This is due to the responses given by the participants which indicated the relative importance of each attitude. Please feel free to share with colleagues and send feedback!

Secondly, I recommend the discussion and use of spiky profiles, with the intension of both boosting confidence in individuals' ability in some topic areas and encouraging peer support, if that seems appropriate. The existence of spiky profiles is commonly understood in ESOL, as some learners may have, for instance, contrasting speaking and writing skills (Colquhoun & Delaney, 2009), but they are perhaps less applied or recently considered in mathematics (Coben, 2003). It was clear from the questionnaire responses that some participants were competent in some topic areas, such as percentages, but others were not. The use of spiky profiles could mean that the latter could be helped by the former if a climate of peer support can be established in the classroom.

Thirdly, the techniques recommended by Barwell (2009) and Swan (2006), among others, to help learners engage with word problems, include asking learners in twos or threes to develop their own word problems (with solutions), and then exchanging the word problems with neighbours for each to solve. The idea here is that the process of understanding of how word problems are constructed could enable easier deconstruction, to identify the necessary mathematics required, which seems to be the challenge for learners in these tasks.

A perusal of the command word content and structure of word problems by teaching staff, so that they are aware of the language that learners will see on examination papers will be invaluable, as teachers can then ensure that they are using the same language in the classroom. However, a word of caution here, as examination boards periodically review and change their command words, and the language used differs from board to board. For instance, one board might use 'convert', whereas another uses 'change', when asking students to 'convert' centimetres to metres.

Lastly, timed testing has been identified as an issue for many participants in this study, whether that was an in-class quiz or a test, as shown in Table 2. Whilst a certain level of adrenalin is necessary for a good performance in tests and examinations, a surfeit of adrenalin invokes the ‘fight or flight’ response which is known to impair brain function (Ashcraft & Moore, 2009). Techniques to manage anxious responses in examinations may need to be included in the taught sessions, so that learners are better able to counteract the effects of a surfeit of adrenalin in the body. Techniques are likely to be different for each person, but one example involves slowing the breathing, which can calm the mind.

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Appendix 1: Revised questionnaire

This questionnaire contains mathematics and examinations confidence scales by Jenny Stacey

Name……Date…….

Think about the situation described and rate how confident you would feel about your ability in each case. Tick the box, or write in the score:

Task	Very confident 1	Quite confident 2	Don't know 3	I don't think I can do this 4	I can't do this 5
Using a times table grid to find out what 7 x 9 is					

Drawing graphs and charts					
Working out 12% of £42					
Finding two thirds of £42					
Working on word problems, such as “If it takes 3 people 5 days to fit a kitchen, how long would it take 2 people?”					
Solving an algebraic equation, such as if 3x -2 = 7, what is the value of x?					
Asking a question in a maths class about something you have not understood					

Think about these situations; how anxious you would feel in each case? Tick and write each score:

Task	No anxiety 1	Some anxiety 2	Moderate anxiety 3	Quite a bit of anxiety 4	High anxiety 5
Thinking about an upcoming maths test one day before					
Taking the final maths exams at the end of your course					
Taking any other exams that are NOT maths					

Now what is your total score? Write it here: [Minimum 10; maximum 50]

Do you have any comments about any of the above? If so, please make them here or overleaf.

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Acknowledgements

Thanks are due to my supervisors, Dr Iain Garner and Dr Peter Rowlett, of Sheffield Hallam University, and to all of the participants.

Author’s biodata

Jenny Stacey, PGCE, L5 Numeracy Specialism, MEd with ESOL, has taught mathematics and occasionally ESOL in FE for almost 20 years. Her speciality is

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