O'Hanlon, A. (2025) The influence of the teacher as a source of mathematics anxiety for adult learners in Further Education and Training. *Adults Learning Mathematics: An International Journal, 19*(1), 45-59

The influence of the teacher as a source of mathematics anxiety for adult learners in Further Education and Training

Adrian O'Hanlon
University of Limerick
Limerick, Ireland
<0420395@studentmail.ul.ie>

Abstract

The Adult Literacy for Life (ALL) Strategy was established to reduce the number of adults in Ireland with unmet numeracy needs from 25% to 12% (Government of Ireland, 2023). Studies suggest that learners' negative attitudes towards mathematics may also develop over a sustained period (Prendergast et al., 2020). Adult learners who have had negative experiences in mathematics find it very difficult to move past these experiences (Boaler, 2016). This can be because of poor experiences within formal education leading to fear and lack of confidence in mathematics, as well as anxiety (Goos et al., 2023).

This article outlines research, which focuses on two research questions. Firstly, "What level of mathematics anxiety, if any, exist amongst a cohort of adult learners?" and secondly "What is the impact of a teacher's role as an environmental factor on the development of mathematics anxiety throughout the mathematical journey of adult learners?". This paper will examine the 'influence of the teacher' as an environmental antecedent. The study comprised of a sequential mixed method approach, the quantitative element was a MAS UK (Mathematics Anxiety Scale) questionnaire (n = 15) and the qualitative element was a mathematics life story interview (n = 8).

The findings show that mathematics anxiety existed at varying levels among these mature students, and that there are significant teaching-environmental antecedents, that contribute to the level of anxiety experienced.

Keywords: mathematics anxiety; numeracy; adult learner; Further Education and Training.

Introduction

Mathematics has a significant ability to produce negative emotions from learners particularly when compared to other subject areas and disciplines (Boaler, 2016). Mathematics anxiety can be responsible for poor performance in mathematics as well as avoidance of the subject (Ashcraft & Moore, 2009; Dowker et al., 2016). According to Hembree (1990), it includes emotional, cognitive, behavioural, and physiological components. Moreover, it affects learners at all levels of the education system (Dowker, Sarkar & Looi, 2016), including Further Education (Betz, 1978; Boaler, 2016).

Literature Review

The literature review focuses on the brief historical background of mathematics anxiety, the antecedents of mathematics anxiety, the environmental antecedents of mathematics anxiety, and the Irish context of mathematics anxiety within Further Education and Training (FET).

Brief history of mathematics anxiety

The infancy of mathematics anxiety goes back at least to the sixteenth century, according to Dowker et al. (2016, p.2), who referenced the verse from a children's song, "Multiplication is vexation ... and practice drives me mad" which illustrates that mathematics anxiety has existed for a long period. Gough (1954) referred to the construct as a 'disease' and suggested it did not require a definition as it was self-explanatory. Di Martino et al. (2011) contend that it has been widely studied with varying attempts to classify its diverse nature. Equally, it is often misunderstood and in some cases, it can be misinterpreted as "just another name for bad at maths" (Beilock & Willingham, 2014, p.29) or perhaps even a dislike for mathematics (Vinson, 2001). Dowker et al. (2016) contend that over the past 60 years, we now have a much greater understanding of the phenomenon which is mathematics anxiety. The following section will explore the environmental antecedents of mathematics anxiety.

Antecedents of Mathematics anxiety

The sources of mathematics anxiety are complex and varied (Jameson, 2010). Ramirez et al. (2018) report there has been significant research carried out, into the causes or sources of mathematics anxiety, however, research has yet to produce conclusive answers. Possible factors include the learner, the influence of teachers, parents, and peers, as well as cultural, societal and environmental influences (Dreger & Aiken, 1961). Aiken (1976) outlines several sources that can impact a learner's mathematics anxiety, including student-teacher interaction, syllabus, teaching methods, teaching resources and support of parents and peers.

Environmental Antecedents of Mathematics Anxiety

Environmental sources are external factors of mathematics anxiety, which are outside of the learner's control (Baloglu & Kocak, 2006; Buckley & Reid, 2013; Cemen, 1987). For example, Baloglu & Kocak, (2006) found that older engineering students experienced mathematics anxiety due to examinations and the perceptions of the engineering course being very difficult. To note, this study had a large sample of 759 volunteer college students from a large southwestern state university in the United States, however only 26.7% were male participants, this could be problematic as gender is associated with mathematics anxiety, i.e. females are more likely to suffer from mathematics anxiety than males (Ramirez & Beilock, 2011).

Examples of environmental factors include the influence of teachers, peers, and parents or simply put, the environment where learners find themselves. Luttenbeger et al. (2018) make a distinction between personal and environmental characteristics. They suggest that personal (dispositional) antecedents comprise individual factors such as gender or prior knowledge in mathematics. Conversely, environmental antecedents include external factors such as educational or cultural values, or the influence of other significant people in their own life. Similarly, Casad, Hale, & Wachs, (2015) suggest environmental factors such as parents, other peers, and teachers.

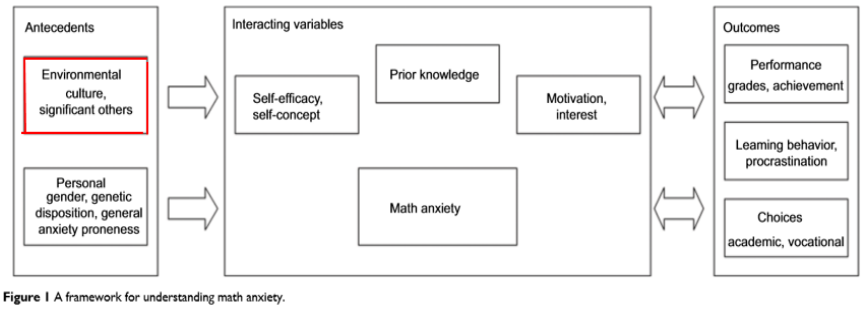


Figure 1: A framework for understanding math anxiety, (Luttenberger, Wimmer and Paechter, 2018, p.313)

The influence of the teacher as an environmental antecedent of mathematics anxiety

The student-teacher interaction can have a significant impact on learners' mathematics anxiety. For example, some adults reported that they developed their mathematics anxiety as a consequence of a teacher reacting angrily when the learner asked for help when they struggled with mathematics (Jackson & Leffingwell, 1999). This negative reaction from a teacher can lead to avoidance of mathematics. A significant issue can be learner embarrassment and fear of getting tasks incorrect in front of teachers and peers. Ashcraft (2002) reported that public embarrassment in mathematics classes contributed to learner's mathematics anxiety.

Negative experiences in mathematics from earlier stages of education can have consequences such as reduced motivation and unpleasant attitudes toward mathematics during a learner's educational journey (Bekdemir, 2010). Turner et al. (2002) speculated that students with teachers who conveyed a high demand for correctness, may feel "vulnerable to public displays of incompetence" (p. 101). Similarly, Mazzocco (2007) suggested that learners can feel nervous or worried about mathematics when they are subject to making mistakes in front of their classmates or receiving negative feedback from teachers. Indeed, learners adopt coping strategies to avoid or reduce negative emotions such as anxiety and embarrassment that often arise from a stressful situation i.e. tests, tasks, or being asked a question (Friedel et al. 2007; Lazarus 1974). Moreover, tests and assessments can contribute towards a learner's mathematics anxiety.

Teaching methods as environmental antecedents of mathematics anxiety

Aiken (1976) identified several factors that can shape students' attitudes toward mathematics teaching methods. Traditional teaching methods do not work for adult learners who have had negative experiences in mathematics (Klinger, 2011, Mutodi, 2014, Delikta and Stojkovska, 2019). Traditional teaching methods can include an environment where learners passively receive information and do not question the teacher's authority (Finlayson, 2014). It can also include an emphasis on learners engaging in rote learning where the emphasis is on memorisation rather than active learning (Cates & Rhymer, 2003). According to Finlayson (2014), traditional learning focuses on the transfer of knowledge from curriculum and textbooks where learners work in isolation with an emphasis on correctness whilst disregarding group work and discussion.

Mutodi (2014) claimed that the best way to reduce mathematics anxiety is for teachers to include fewer lectures, include more student-directed classes and more learner collaboration. Turner et al. (2002) speculated that students with teachers who conveyed a high demand for correctness may feel "vulnerable to public displays of incompetence" (p. 101). Similarly, Mazzocco (2007) suggested that learners can feel nervous or worried about mathematics when they are subject to making mistakes in front of their classmates or receiving negative feedback from teachers. Indeed, learners adopt coping strategies to avoid or reduce negative emotions such as anxiety and embarrassment that often arise from a stressful situation i.e. tests, tasks, or being asked a question (Friedel et al. 2007; Lazarus 1974).

Curtain-Phillips (1999) stated that to lessen the development of mathematics anxiety, there should be less teacher-directed input, more student-led classes and general discussions, and mathematics relevant to children's everyday lives. Some of the literature on the influences of the teacher on mathematics anxiety collaborates with the theory of andragogy, which is particularly relevant given the nature of this study. For example, mathematics anxiety can be derived from a teacher's anger (Jackson & Leffingwell, 1999), correctness (Finlayson, 2014), public displays of incompetence (Turner et al. 2007), and the embarrassment of the learner (Mazzocco, 2007). Fiore's (1999) defines mathematics abuse, in terms of the onset of mathematics anxiety as a consequence of "any negative experience related to an individual's doing mathematics" (1999,

p.403). This can be exacerbated, where the student has been subjected to verbal or physical abuse (Fiore, 1999).

Moreover, Knowles's (1980) theory of andragogy advocated that adult learners should feel respected, supported and that adults should never be 'talked down to' and advocated the use of non-traditional teaching methods such as active learning and the use of real-life scenarios (Knowles et al., 2012). A recent study found that a 'jigsaw' collaborative learning method significantly reduced mathematics anxiety by fostering a supportive, peer-driven environment where students felt less pressure to perform individually (Azizi. et al, 2024).

Irish context

A recent Irish numeracy report *Towards a New Literacy, Numeracy and Digital Literacy Strategy* (2023) stated that one of the crucial challenges in numeracy research is that, unlike literacy, there is no consensus as to what exactly numeracy is. Adult numeracy in Ireland, is generally targeted at those who have limited or significant challenges in learning mathematics in a traditional setting (Goos et al., 2023). These challenges typically affect older adults who have experienced interruptions or dropped out of school (Goos et al., 2023). The Adult Literacy for Life (ALL) Strategy was established to address unmet literacy, numeracy and digital literacy needs for people across Ireland, one specific target was to reduce the number of adults in Ireland with unmet numeracy needs from 25% to 12% (Government of Ireland, 2023).

Low levels of numeracy among adults can have serious consequences often associated with socioeconomic disadvantage, with individuals from disadvantaged backgrounds leading to intergenerational cycles of low levels of mathematics anxiety (NALA, 2019). In Ireland, adult numeracy education typically targets those who have had limited opportunities or significant difficulties in learning mathematics in a formal school environment (Goos et al., 2023). National Adult Literacy Agency (NALA), one of the key agencies in FET and adult numeracy in Ireland, commissioned '*A report on adult learner's understanding and conceptualisation of numeracy in Ireland*' (NALA, 2022). One of the key findings was that dispositions, such as confidence and beliefs were significant. Many participants in this study only associated negative dispositions towards the particular mathematical concept, with many indicating that they were suffering from mathematics anxiety (NALA, 2022). With this in mind, it is imperative to explore the source or what is referred to as the antecedent of mathematics anxiety. Understanding this can help numeracy policymakers and practitioners to reduce the unmet numeracy needs from 25% to 12%.

Methodology

The research design involved initially measuring mathematics anxiety in a group of learners using quantitative data. Subsequently, to explore various antecedents, a mixed-methods sequential explanatory design was chosen. This approach, widely utilized, involves collecting and analyzing quantitative data first, followed by qualitative data in two consecutive phases within a single study (Ivankova, Creswell, & Stick, 2006). The following research questions underpinned this study

1. What level of mathematics anxiety, if any, exist amongst a cohort of adult learners?
2. What is the impact of a teacher's role as an environmental factor on the development of mathematics anxiety throughout the mathematical journey of adult learners?

The MAS-UK questionnaire

The MAS-UK questionnaire (Hunt et al., 2011) was used to measure the learner's initial level of mathematics anxiety. The MAS-UK is the only mathematics anxiety measurement specifically designed for adults. This is a significant factor as this research study consists exclusively of an

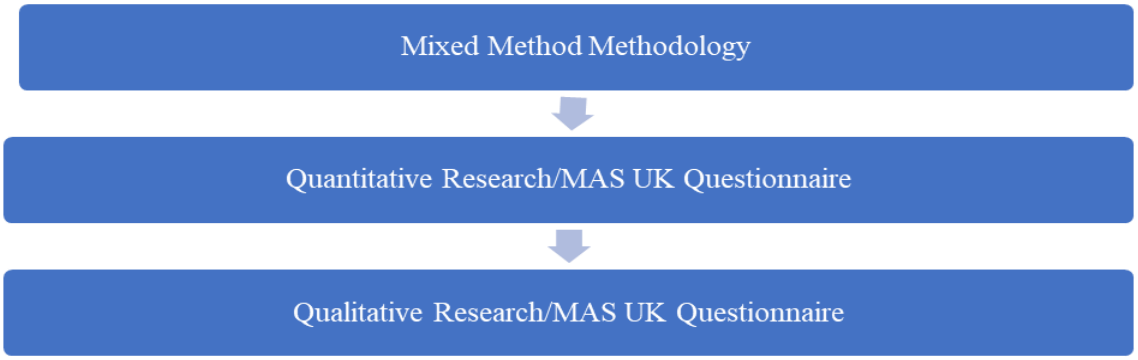
adult population. Additionally, the MAS-UK test has demonstrated significant internal reliability (Cronbach's alpha = 0.96) and test-retest reliability (r = 0.89) (Hunt, Clark-Carter & Sheffield, 2014). To date, there is no mathematics anxiety test designed specifically for an Irish population, the MAS-UK was developed for the British population (Hunt, Clark-Carter, & Sheffield, 2011), which in terms of language would be most appropriate for an Irish population. There is also existing literature, where the MAS-UK test was used to measure mathematics anxiety among adult learners in Irish Universities e.g. Ryan, Fitzmaurice. & Johnson (2019), Ryan & Fitzmaurice (2017) and Ryan (2019). The MAS UK questionnaire seemed most appropriate for the participants in this study. However, how to analyse the results required greater research and consideration.

Hunt (2022), the creator of the MAS-UK, recommended interpreting the scale as a continuum rather than relying on fixed cut-off points for categorisation. Higher scores on the MAS-UK reflect increased levels of mathematics anxiety, with the highest scores indicating extreme anxiety. Similarly, Cipora et al. (2019) argued that mathematics anxiety should be treated as a continuous trait, where even lower scores suggest some level of anxiety, albeit less severe. While categorisation may not be essential, recognising high scores as indicative of significant anxiety can assist with interpretation. Comparing results from other studies using the MAS-UK could further support its application.

The Mathematics Life Story

The mathematics life story was used for the qualitative aspect of the mixed method approach. A life story, through a semi-structured or unstructured interview (Drake, 2006; McAdams, 1993), provides an understanding of a learner's past experience(s) (Goodson & Sikes, 2001). Exploring a learner's journey from their past enables the researcher to understand their present (Mertens, 2015). Life Stories have been adapted to Mathematics Life Stories to make it more appropriate for a learner's mathematics journey. The purpose of the mathematics life story is to illustrate the narrator's past and present experiences in mathematics (Ryan, 2019), particularly "with respect to those areas of adults' lives which they do not immediately identify as mathematical" (Thumpston, & Coben, 1995, p.32). The rationale underpinning the use of mathematics life story as a research tool is that it "gives instructors insight into the background of their students" (LoPresto & Drake, 2004, p. 268). It has evolved from the life story and offers a deep insightful account of a learner's experiences in mathematics, which is particularly helpful given the participant's journey to adult education. Ryan (2019) developed the mathematics life story framework as an adaptation to McAdam's (1993) interview. Ryans' (2019) study conducted similar research where the focus was on the existence of mathematics anxiety amongst mature students in higher education. Furthermore, McAdams, (1993) and Plummer (2001) advocate preparing the narrator for the interview and allowing them to record post-interview thoughts.

Research Process



Participant selection

Given the small number of available participants due to the complexities of COVID-19, a convenience sampling method was employed. Convenience sampling is a sampling method where members of the target population that meet specific practical criteria, such as easy accessibility, geographical proximity, availability at a certain time, or the willingness to participate are included for the purpose of the study (Dörnyei, 2007). In this study, and similar to Dörnyei (2007), "captive participants such as students in the researcher's institution are main examples of convenience sampling" (Dörnyei, 2007, p. 6). An information session was held by the Active Inclusion Support Service (AISS) Coordinator and two leaving-certificate classes from Vocational Training Opportunities Scheme (VTOS) in Limerick City were invited. There was a total of 22 between both, of which 15 participants volunteered for the MAS UK questionnaire and 7 declined. Of those 15 learners, (n = 8) volunteered for the Mathematics Life Story Interview framework and (n = 7) declined. The names in the date below are pseudonyms provided to protect the identity of each participant.

Analysis of Data

There are various approaches to thematic analysis (e.g. Alhojailan, 2012; Boyatzis,1998; Javadi & Zarea, 2016). Peel (2020) gives an overview of the four prominent writers in thematic analysis (1) Braun and Clarke (2006), (2) Creswell (2013), (3) Merriam (2008) and (4) Miles, Huberman and Saldaña (2014). All of these approaches were examined; however, the researcher chose Braun and Clarke (2006) as it was straightforward to follow, guiding around potential pitfalls in thematic analysis, it was more comprehensive in terms of its stages, and it also enabled reflective practice. According, to Maguire & Delahunt (2007) it is arguably the most influential approach as it offers such a clear and usable framework for doing thematic analysis. Indeed Byrne (2022, p.1.) argued "since the publication of their inaugural paper on the topic in 2006, Braun and Clarke's approach has arguably become one of the most thoroughly delineated methods of conducting thematic analysis". Braun and Clarke (2006) provided a six-step process compared to a five-step process which Creswell (2013), Merriam (2008) and Mils et al. (2014) offered. The advantage of this is that it guides the researcher on a step-by-step basis which is very clear and comprehensive.

Ethical Considerations

The research was conducted in accordance with the University of Limerick's ethical guidelines at all times where concerns such as ethics, how participants were treated and how the various research activities were explored. The research received ethics approval from the Education and Health Sciences Research Ethics Committee

The researcher had to ensure that his position as a teacher did not impact on bias through regular discussions with participants, who were also informed that the data would be stored securely and that they could not be identified as they would be given pseudonyms, thus ensuring anonymity. Another ethical consideration that was addressed, was to ensure that participation was completely voluntary. In addressing this, it was decided that the AISS (Activation Inclusion Support Service) officer would send a letter inviting learners to participate where they were informed that participation was completely voluntary and that there would be no implications if they did not partake in the research study.

Findings

Research question 1: What level of mathematics anxiety, if any, exist amongst a cohort of adult learners?

There was a total of 23 questions from the MAS UK Questionnaire, where learners expressed their level of anxiety on a scale from 1 to 5 from 'not at all' to 'very much'. This would mean an individual score would range from a minimum of 23 to a maximum of 115. There was a total of 15 questionnaires completed and the mean was 52.33 with a standard deviation of 18.2. Ryan (2019) carried out a MAS UK questionnaire (n = 107) on university adult learners in an Irish university with a mean of 55.2, a median 56.5, and a standard deviation of 18.19. This implies that there is no significant variation between adult learners' mathematics anxiety in third-level education compared to learners in FET. It is important to note that these are quantitative findings, and the sample size is much greater in Ryan's (2019) study.

Table 1. Overview of MAS UK Scores

Name	Mas UK Score	Name	Mas UK Score
Stephen	26	Robert	56
Brendan	27	Thomas	58
Sarah	27	Stacy	75
Linda	36	David	54

Tests of normality were also carried out. Researchers recommend the Shapiro-Wilk test as the best choice for testing the normality of data (Thode, 2002). The Shapiro-Wilk test showed a significance of ($p = 0.121$), which suggests the data are normally distributed. A visual inspection of the histograms, normal Q-Q plots and box plots also confirms these results. Table 1 gives the results of the MAS UK questionnaire, showing a snapshot of the levels of anxiety among the participants in the study who volunteered for the second phase of the research process i.e. the mathematics life story interview. The findings from this table show that mathematics anxiety does exist among a cohort of adult learners, to note, at the point of assessment there existed a variance in levels of mathematics anxiety across the cohort of participants with some holding higher levels of anxiety.

Research question 2: ***What is the impact of a teacher's role as an environmental factor on the development of mathematics anxiety throughout the mathematical journey of adult learners?***

The qualitative data were derived from a thematic analysis of the mathematics life story interview incorporating the Braun and Clarke (2006) six-step process. The themes of 'learning environment' and 'traditional/non-traditional' learning' were synthesized to 'the influence of the teacher'. Klinger (2011) highlighted that the challenge for all teachers in adult education is to find an effective approach to address mathematics anxiety. Within this theme, the dominant factors for learners in FET, were teaching methods, embarrassment and punishment. Embarrassment and punishment were further synthesised to' mathematics abuse'.

The purpose of this section it to the draw on the findings in addressing research question 2. The influence of the teacher had a significant impact on learners' mathematics anxiety. Within this study, it was found that teaching methods were a significant environmental antecedent for

mathematics anxiety even with the varying ages of adult learners and the jurisdictions where learners were taught including the use of traditional teaching methods. The following sections will outline the different themes that surfaced throughout the thematic analysis.

Influence of the teacher

In terms of the influence of the teacher, the dominant theme that emerged from the thematic analysis, was mathematics abuse and the use of traditional teaching methods. It is well-reported that traditional teaching methods do not work for adult learners who have had negative experiences in mathematics (Boaler, 2010; Haylock, 2018, Klinger, 2011, Mutodi, 2014, Delikta and Stojkovska, 2019). A number of participants including Linda, Sarah, Stephen, Robert and David raised the issue of traditional teaching. Traditional teaching methods in this study included didactic teaching, whilst mathematics abuse includes embarrassment and corporal punishment. The next section will outline some of the extracts from the mathematics life story which were examples of environmental antecedents of mathematics anxiety.

Embarrassment

As early as primary school, many learners recalled embarrassment and anxiety when being called to the blackboard or having to go through their 'times tables'. This certainly resonates with Bekdemir (2010) who warned that negative experiences in mathematics from earlier stages of education can lead to negative unpleasant attitudes toward mathematics during a learner's educational journey. This was prevalent across a number of participants, which in many cases led to mathematics avoidance.

Ashcraft (2002) reported that public embarrassment in mathematics classes contributed to learner's mathematics anxiety. Shields (2005) supported this concern and referenced unrealistic expectations, intimidation, and insensitivity. Embarrassment in front of peers can lead to mathematics anxiety for learners. Moreover, Turner et al. (2002, p.101), also suggested that students with teachers who demand correctness may feel, "vulnerable to public displays of incompetence".

Linda's experience of embarrassment supports this statement when she recalls her experience of having to go to the board in mathematics class and states "she (the teacher) wanted you to give the answer quickly. You were really stressed in front of the class". Stacy also shared a similar experience when being asked to recite 'times tables' in front of the class in which she displays feelings such as embarrassment and anxiety, particularly in front of her peers "Kids at that age are kind of ruthless, they were kind of laughing and smirking because I think at that age I should have known them". David, who came from a different jurisdiction, also recalled an embarrassing situation in his mathematics class as a child. David recalled "the teacher, will humiliate you know! I mean, if you have a bad grade, teacher will call out the grade in the front of the whole class if you get something wrong. Or something they make you they don't like it, they just go may say OK, go stand facing the wall with your hands up". The evidence in this study as well as others clearly shows that teachers need to be aware of how learners are assessed in front of their peers, as it can lead to such negative unpleasant attitudes in mathematics including anxiety and embarrassment. Stacy, Linda, and Thomas experienced embarrassment in front of their peers, which had a negative impact on their self-esteem. Cemen's (1987) *Model of a Mathematics Anxiety Reaction* outlines several environmental antecedents to mathematics anxiety, including 'embarrassment and feeling stupid'. Apart from mathematics anxiety, it can also mean that the learner is discouraged from engaging in questioning or asking for help (Ashcraft & Krause, 2007; Fiore, 1999).

Corporal Punishment

Another example of traditional teaching is the use of corporal punishment. The use of corporal punishment, particularly after failure, has been shown to have a positive relationship with mathematic anxiety (Frenzel, Pekrun & Goetz, 2007).

One example of this is when Stephen recalled watching others subjected to corporal punishment and how it impacted his mathematics anxiety, "I used to watch the others getting sort of a beaten for not knowing them (times tables). So, I always was able to sing off the tables, you know that was in second and third class, I suppose with an element of fear as well".

Thomas who had a similar experience stated, "The teacher used to come and the mosque there was a few trees there is so. He's used to cut a big stick from one of the trees…end of the day stick (it) would have been to 20 pieces".

The use of corporal punishment is not unique to this study, indeed Ryan (2019, p.190) interviewed 'Jon', a learner in higher education who stated, "If you got the slightest thing wrong, you got beat, and one teacher would slap you across the knuckles. Another teacher would beat you, just lose her temper because she felt you were thick, and that's what she would be telling you". What is interesting is that Ryan (2019) reported that corporal punishment did not prevent the learner from progressing in mathematics but there was a 'regime of terror' that stayed with the learner throughout his mathematics journey.

C***halk and talk***

There has been a growing demand to change traditional teaching methods to more contemporary approaches, despite this; the former is still commonly used (Earle & Rickard, 2018; Geist, 2010; Geist & King, 2008). It is important to note that many learners in this study were returning to education after a significant time and there has been a number of initiatives for more active learning approaches in mathematics at leaving certificate (Shiel & Kelleher, 2017). Within this study, many learners also complained of traditional teaching or didactic teaching that they found to be very ineffective.

Robert felt that how mathematics was taught didn't relate to the outside world "I really didn't like it cause it didn't teach anything about the outside world. It was only as I learned before that maths (mathematics) in school was only useful if you wanted to become a teacher afterwards".

Linda complained of didactic teaching and lack of active learning "it was just teacher sitting by the desk or standing by the board. Explaining and writing and we didn't really had that kind of classes that we could measure something or like in like maths (mathematics) In practice it was very low in my life".

Stephen shared didactic experiences to learning where questioning was not tolerated, "No, he (The Teacher) just went to the board and he just said opened up page 55 yeah. Stephen then asked the Teacher to explain and he was met with aggression "You know he come down to me and then he 'grabbed me'". David also shared the issue of questioning, "Sometimes the teacher would be like come on I'm not going to answer this, you know it says. Come on, you know you're in higher level".

Discussion

As stated, it is evident that mathematics anxiety does exist, to varying degrees, amongst the further education and training learners in this study. The level of mathematics anxiety ranged from very

low levels to high. This study showed that FET did not differ from other sectors such as higher education, in terms of the extent of mathematics anxiety for adult learners.

The issue of teaching methods prompts further discussion. There is ample evidence that teaching methods in mathematics can result in mathematics anxiety for learners (Wilbert, 2008 Ashcraft, 2002; Hellum, 2010). Teachers of mathematics in FET need to be aware of these consequences and incorporate alternative approaches to teaching mathematics if mathematics anxiety is to be addressed. Within this study, it was found that teaching methods were a significant environmental antecedent for mathematics anxiety even with the varying ages of adult learners and the jurisdictions where learners were taught including the use of traditional teaching methods.

An alternative approach to teaching mathematics in FET

Clearly, there is a discourse required on how mathematics is taught to FET learners. According to Knowles's (1980) theory of andragogy, adults exhibit different learning styles, for example, adult learners tend to bring life experience to the classroom and prefer self-direction (Knowles, 1980). Learners in this study, reported that traditional teaching approaches to mathematics does not work and in many cases gave rise to mathematics anxiety.

It is well-reported that traditional teaching methods do not work for adult learners who have had negative experiences in mathematics (Boaler, 2010; Haylock, 2018, Klinger, 2011, Mutodi, 2014, Delikta and Stojkovska, 2019). Some participants, including Linda, Sarah, Stephen, Robert, and David raised the issue of traditional teaching. Traditional teaching methods in this study included didactic teaching, punishment, and embarrassment. Moreover, a move towards more student-centred, constructivist teaching methods holds the potential to mitigate the advancement of mathematics anxiety in students.

Contemporary approaches to teaching

This study found that traditional teaching methods do not work for adult learners who have had negative experiences in mathematics, similar to other findings (Klinger, 2011, Mutodi, 2014, Delikta and Stojkovska, 2019) and that the incorrect teaching approach can result in mathematics anxiety for learners (Wilbert, 2008 Ashcraft, 2002; Hellum, 2010). This prompts the discussion, what is the correct approach to teaching adults mathematics whilst also considering interventions to reduce learners' mathematics anxiety?

Shields (2005) warned that mathematics anxiety will continue to develop unless interventions such as effective pedagogy, inquiry, enthusiasm, and discovery are implemented. Methods to reduce mathematics anxiety include fewer lectures, more student-directed classes, and increased collaboration (Mutodi, 2014; Curtain-Phillips, 1999). One potential strategy to address this issue is the implementation of a flipped classroom model, especially in light of the increasing popularity of blended learning in mathematics classes within FET.

Segumpan and Tan (2018), an advocate of the flipped classroom approach, found that mathematics anxiety decreased significantly compared to the traditional classroom. The authors felt that the asynchronous aspect gave students ample time to prepare outside and before class. Asynchronous can include the use of notes, books, podcasts or videos. Indeed, the use of ICT to facilitate mathematics learning has been used to counteract mathematics anxiety (Furner & Duffy, 2002; Sun & Pyzdrowski, 2009).

Non-traditional approaches are not limited to the use of ICT, for example, Lavasani and Khandan (2011) found the use of cooperative learning beneficial and that learners experienced less mathematics anxiety compared with students who were taught using a traditional method of learning. These interventions may reduce mathematics anxiety for learners but adequate support is also required, which will now be discussed. It is important to note, that despite the widespread

availability of online mathematics resources, a recent study found that most mature students held a preference for the interpersonal engagement of teaching staff (Breen, Prendergast & Carr, 2015).

Treating mathematics learners with respect

Prendergast et al. (2020) suggested that negative attitudes towards mathematics develop over a sustained period. In this study, it was certainly evident that participants reported negative attitudes towards mathematics across several jurisdictions. In many cases, learners drew on their negative experiences as far back as primary school where they were either asked to recite 'times tables' or go to the blackboard to solve mathematical questions.

Knowles (1980) advocated that adult learners should feel respected, supported and that the classroom should be constructed in an 'adult friendly' manner, he also suggested that adults should never be 'talked down to'. Since 1982, corporal punishment has been banned in Ireland; however, learners who have experienced this still present themselves in both further and higher education, as evident in the two previous examples. Teachers and institutions in FET need to be cognisant that learners may have had a history of corporal punishment.

Conclusion

The purpose of this study was to address the two research questions. It is envisaged that the outcomes of this research will inform mathematics and numeracy teachers/tutors in FET on the prevalence of mathematics anxiety and the influence of the teacher as a source of mathematics anxiety for adult learners in FET.

This information holds the potential to support andragogical interventions to help mitigate mathematics anxiety amongst FET students and to reduce associated negative outcomes. Moreover, the findings also hold the potential to help advance teachers' empathy and respect for learners by better understanding the mathematics life stories of such adult learners.

Research shows that negative attitudes towards mathematics may well have been learned by students and have developed over a sustained period of time (Prendergast et al., 2020). Therefore, FET Teachers must convey a positive attitude towards mathematics. There is a significant gap in the study of mathematics anxiety within FET, as well as very limited research in an Irish context.

The findings from this study, can draw on a number of implications for numeracy and mathematics policy for adult learners in further education and training in Ireland. Financial investment has significantly increased within FET in Ireland, particularly since 2020. This approach has had a positive impact and perhaps on a sector which was often overlooked, often undervalued and less prestigious (McGuinness et al., 2014). The (ALL) Strategy was recently established and has taken a positive approach towards addressing numeracy, one specific target was to reduce the number of adults in Ireland with unmet numeracy needs from 25% to 12% (Government of Ireland, 2023). This objective is significant, as not only does numeracy have economic implications for society, but it can also lead to socioeconomic disadvantage, and intergenerational cycles of low levels of mathematics anxiety for individuals (NALA, 2019).

Whilst not limited to any specific sector of society, some marginalised groups that require numeracy support can include refugees, long-term unemployed, low-paid workers, persons with disabilities, and ethnic minority groups such as Irish Travellers (Government of Ireland, 2021). Goos et al. (2023, p.1006) suggested a discourse is required between numeracy policymakers and how they "*perceive the numeracy capabilities needed by adults to exercise their rights as*

responsible and critical citizens". With this in mind, it is important to view all of these important details within the context of government and numeracy policy.

References

Aiken, L. R. (1976). Update on attitudes and other affective variables in learning mathematics. *Review of educational research*, 46(2), 293-311.

Aiken, L. R. (1976). Sources of mathematics anxiety in high school students. *Journal for Research in Mathematics Education,* 7(5), 315-320.

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Directions in Psychological Science,* 11(5)*,* 181-185.

Ashcraft, M. H., Kirk, E. P., & Hopko, D. (2022). On the cognitive consequences of mathematics anxiety. In C. Donlan (Ed.), *The development of mathematical skills,* (pp. 174-196). Psychology Press.

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review,* 14*,* 243–248.

Ashcraft, M.H. & Moore, A.M. (2009). Mathematics Anxiety and the Affective Drop in Performance, *Journal of Psychoeducational Assessment,* 27(3), 197-205.

Azizi, M. Z., Atef, A., & Seddiqi, N. (2024). The effectiveness of the jigsaw and traditional teaching methods on math anxiety, attitude, and performance. *Journal of Mathematics and Statistics Studies,* 5(1), 27-33.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences,* 107, 1860–1863.

Beilock, S. L., & Maloney, E. (2015). Math anxiety: A factor in achievement not to be ignored. *Behavioral and Brain Sciences,* 2(1), 4-12.

Beilock, S. L., & Willingham, D. T. (2014). Math anxiety: Can teachers help students reduce it? *American Educator, Summer 2014*, 28-32.

Baloglu, M., & Koçak, R. (2006). A multivariate investigation of the differences in mathematics anxiety. *Personality and Individual Differences,* 40, 1325–1335.

Bekdemir, M. (2010). The pre-service teachers' mathematics anxiety related to depth of negative experiences in mathematics classroom while they were students. *Educational Studies in Mathematics,* 75(3), 311–328. https://doi.org/10.1007/s10649-010-9260-7

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology,* 25, 441–448.

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through Creative Math, Inspiring Messages and Innovative Teaching*. Jossey Bass.

Boaler, J. (2010). *The elephant in the classroom: Helping children love and learn mathematics*. Souvenir Press.

Boaler, J., Dieckmann, J. A., Pérez-Núñez, G., Liu Sun, K., & Williams, C. (2018). Changing students' minds and achievement in mathematics: The impact of a free online student course. *Frontiers in Education,* 3, 1-7.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3*,* 77-101.

Byrd, P. G. (1982). A descriptive study of mathematics anxiety: Its nature and antecedents (Doctoral dissertation, Indiana University).

Buckley, S., & Reid, K. (2013, August 05). Learning and fearing mathematics: insights from psychology and neuroscience [Paper presentation]. 2013 - How the Brain Learns: What lessons are there for teaching?. https://research.acer.edu.au/research_conference/RC2013/5august/17

Cates, G. L., & Rhymer, K. N. (2003). Examining the relationship between mathematics anxiety and mathematics performance: An instructional hierarchy perspective. *Journal of Behavioral Education,* 12*,* 23-34.

Casad, B. J., Hale, P., & Wachs, F. L. (2015). Parent-child math anxiety and math-gender stereotypes predict adolescents' math education outcomes. *Frontiers in Psychology,* 6*,* 1597.

Cemen, P. B. (1987). The nature of mathematics anxiety. ERIC Document Dissertation ED. 287729. https://eric.ed.gov/?id=ED287729

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research*. Sage.

Di Martino, P., & Zan, R. (2011). Attitude towards mathematics: A bridge between beliefs and emotions. *International Journal on Mathematics Education,* 43*,* 1-19.

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? *Frontiers in Psychology,* 7, 1-16.

Dreger, R. M., & Aiken, L. R. (1957). The identification of number anxiety in a college population. *Journal of Educational Psychology,* 48, 344-351.

Fiore, G. (1999). Math-abused students: Are we prepared to teach them? *Mathematics Teacher,* 92(5), 403-406.

Fitzmaurice, O., Mac an Bhaird, C., Ní Fhloinn, E., & O'Sullivan, C. (2015). Adult learners and mathematics learning support. *Adults Learning Mathematics: An International Journal, 10*(1), 68-83.

Finlayson, M. (2014). Addressing math anxiety in the classroom. *Improving Schools,* 17(1), 99-115.

Friedel, J. M., Cortina, K. S., Turner, J. C., & Midgley, C. (2007). Achievement goals, efficacy beliefs, and coping strategies in mathematics: The roles of perceived parent and teacher goal emphases. *Contemporary Educational Psychology,* 32*,* 434–458.

Gill, O., & O'Donoghue, J. (2007). Justifying the existence of mathematics learning support: Measuring the effectiveness of a mathematics learning centre. In J. O'Donoghue & T. Maguire (Eds.), *The changing face of adults mathematics education: Learning from the past, planning for the future* (pp. 146-153). Proceedings of the Adults Learning Mathematics (ALM) 14th annual international conference, University of Limerick, Ireland.

Goos, M., Prendergast, M., O'Meara, N., & O'Sullivan, K. (2023). Supporting adults to become numerate citizens: A study of adult numeracy provision in Ireland. *ZDM Mathematics Education*. https://doi.org/10.1007/s11858-023-01480-9

Government of Ireland. (2021). *Adult literacy for life: A 10-year adult literacy, numeracy and digital literacy strategy*. https://www.solas.ie/f/70398/x/b78324692b/15607_all_strategy_web.pdf

Government of Ireland. (2023). *Towards a new literacy, numeracy and digital literacy strategy*. Gov.ie. Available online: https://www.gov.ie/en/publication/3f341-towards-a-new-literacy-numeracy-and-digital-literacy/

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Perceived learning environment and students' emotional experiences: A multilevel analysis of mathematics classrooms. *Learning and Instruction,* 17, 478-493.

Haylock, D. (2018). *Mathematics explained for primary teachers* (6th ed.). Sage.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education,* 21(1), 33-46.

Hunt, T. E., Clark-Carter, D., & Sheffield, D. (2011). The development and part validation of a U.K. scale for mathematics anxiety. *Journal of Psychoeducational Assessment,* 29*,* 455-466.

Jackson, C. D., & Leffingwell, R. J. (1999). The role of instructors in creating math anxiety in students from kindergarten through college. *Mathematics Teacher,* 92(7), 583-587.

Javadi, M., & Zarea, K. (2016). Understanding thematic analysis and its pitfalls. *Journal of Client Care,* 1(1), 33-39.

Jameson, M. M. (2013). Contextual factors related to math anxiety in second-grade children. *The Journal of Experimental Education*. Advance online publication. https://doi.org/10.1080/00220973.2013.813367

Klinger, C. (2006). Challenging negative attitudes, low self-efficacy beliefs, and math-anxiety in pre-tertiary adult learners. *Proceedings of Adults Learning Mathematics 12*, Melbourne, Australia, 164–171.

Klinger, C. M. (2011). 'Connectivism': A new paradigm for the mathematics anxiety challenge? *Adults Learning Mathematics: An International Journal,* 6(1), 7–19.

Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy* (2nd ed.). Cambridge Books.

Lazarus, M. (1974). Mathophobia: Some personal speculations. *National Elementary Principal,* 53(2), 16–22.

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology Research and Behavior Management*, 11, 311-322. https://doi.org/10.2147/PRBM.S141421

Mazzocco, M. M. M. (2007). Defining and differentiating mathematical learning disabilities and difficulties. In D. B. Berch & M. M. M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities,* (pp. 29-47). Paul H. Brookes.

McAdams, D. P. (1993). *The stories we live by: Personal myths and the making of the self*. The Guilford Press.

Merriam, S. B. (2008). *Adult learning theory for the twenty-first century*. Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage Publications.

Mutodi, P., & Ngirande, H. (2014). Exploring mathematics anxiety: Mathematics students' experiences. *Mediterranean Journal of Social Sciences,* 5(1), 283.

National Adult Literacy Agency [NALA]. (2013). *Doing the maths: The training needs of numeracy tutors in Ireland, 2013 and beyond*. NALA. https://www.nala.ie/publications/doing-the-maths-the-training-needs-of-numeracy-tutors-2013-and-beyond/.

National Adult Literacy Agency [NALA]. (2015). *A framework for meeting the professional development needs of tutors of adult numeracy in the Irish further education and training sector*. NALA. https://www.nala.ie/publications/a-framework-for-meeting-the-professional-development-needs-of-tutors-of-adult-numeracy-in-the-irish-further-education-and-training-sector/.

National Adult Literacy Agency [NALA]. (2017). *A review of adult numeracy policy and practice in Ireland*. NALA. https://www.nala.ie/resources/review-adult-numeracy-policy-and-practice-ireland.

National Adult Literacy Agency [NALA]. (2020). *Literacy now: The cost of unmet literacy, numeracy and digital skills needs in Ireland and why we need to act now*. NALA. https://www.nala.ie/publications/literacy-now/.

National Adult Literacy Agency [NALA]. (2022). *Numeracy definition report: A report on adult learners' understanding and conceptualisation of numeracy in Ireland*. NALA. https://www.nala.ie/publications/numeracy-definition-report/.

National Adult Literacy Agency [NALA]. (2023). *Literacy and numeracy in Ireland*. NALA. https://www.nala.ie/literacy-and-numeracy-in-ireland/.

Plummer, K. (2001). *Documents of life 2: An invitation to a critical humanism*. Sage.

Prendergast, M., & O'Donoghue, J. (2014). Unravelling the myth of effective teaching in mathematics. *Irish Journal of Academic Practice,* 3(1), 8. http://dx.doi.org/10.21427/D7WX43.

Prendergast, M., Johnson, P., Fitzmaurice, O., Liston, M., O'Keeffe, L., & O'Meara, N. (2014). Mathematical thinking: Challenging prospective teachers to do more than 'talk the talk'. *International Journal of Mathematical Education in Science and Technology,* 45(5), 635–647.

Prendergast, M., Ní Ríordáin, M., Ní Shúilleabháin, A., Johnson, P., & O'Rourke, I. (2020). An attitudinal snapshot of pre-service secondary mathematics teachers. *Issues in Educational Research,* 30(1), 283–301.

Ramirez, G., & Beilock, S. L. (2011). Writing about testing worries boosts exam performance in the classroom. *Science,* 331, 211–213.

Ramirez, G., Chang, H., Maloney, E. A., Levine, S. C., & Beilock, S. L. (2018). On the relationship between math anxiety and math achievement in early elementary school: The role of problem-solving strategies. *Journal of Experimental Child Psychology,* 167, 1-17.

Ryan, M., & Fitzmaurice, O. (2017). Behind the numbers: The preliminary findings of a mixed methods study investigating the existence of mathematics anxiety among mature students. *Adults Learning Mathematics: An International Journal,* 12(1), 49-58.

Ryan, M. D., Fitzmaurice, O., & Johnson, P. (2019). Divorce, evil, and the regime of terror: Personal characterisations of mathematics in the lives of mature students. *Adults Learning Mathematics: An International Journal,* 14(1), 34-40.

Shields, D. J. (2005). Teachers have the power to alleviate math anxiety. *Academic Exchange Quarterly,* 9(3), 326-331.

Thode, H. J. (2002). *Testing for normality*. Marcel Dekker.

Thumpston, G., & Coben, D. (1995). Getting personal: Research into adults, maths life histories. In Coben, D. (Comp.), *ALM1 (Proceedings of the Inaugural Conference of Adults Learning Maths - A Research Forum)*. Goldsmiths College, University of London in association with ALM.

Turner, J. C., Midgley, C., Meyer, D. K., Gheen, M., Anderman, E. M., Kang, Y., & Patrick, H. (2002). The classroom environment and students' reports of avoidance strategies in mathematics: A multimethod study. *Journal of Educational Psychology,* 94*,* 88–106.

Wilbert, L. T. (2008). *High school mathematics teachers' perception of students with math anxiety* (Doctoral dissertation). Tennessee State University.